Cover Photo is a vista in the Bighorn National Forest with an aspen stand in the foreground. (Photo by K. Schotzko.)

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Report of the Rocky Mountain Region (R2)

2016 Forest Health Conditions

R2-2017-RO-31

Section 1 - 2016 Forest Health (FH) conditions of the National Forests (NF) in the Rocky Mountain Region (R2). These 12 reports to the National Forests were produced by the Gunnison, Lakewood, and Rapid City Service Centers in R2 Forest Health Protection (FHP).

Section 2 – Internet links to the Colorado, Kansas, Nebraska, South Dakota, and Wyoming 2015 Forest Health Highlights (FHH) reports. These FHH reports were produced by state forest health specialists and discuss the latest FHH from all forestlands in each state.

Section 3 **–** Links to the 2016 Aerial Detection Survey (ADS) Highlights & Maps for Colorado, Wyoming, and South Dakota. These were produced by GIS specialists and surveyors of the respective R2 ADS program.

Section 4 - Additional documentation and acknowledgements.

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Approved by State and Private Forestry, and Tribal Relations Director, Jenna Sloan – August 2017

2016 Forest Pest Conditions Highlight: Arapaho and Roosevelt National Forests

USDA Forest
Service Rocky
Mountain Region
Forest Health
Protection Lakewood
Service Center 740
Simms Street
Golden, CO 80401

Conditions Highlights

Spruce beetle activity decreased in Colorado and southern Wyoming from 410,000 acres in 2015 to 350,000 in 2016. Of this, 12,000 and 4,400 acres were affected on the Arapaho and Roosevelt National Forests (ARNF), respectively. Mortality was concentrated in and increased in the Canyon Lakes and Sulphur Ranger Districts along the northern and western borders of Rocky Mountain National Park (RMNP). Numerous windthrow events since 2011 increased the potential for spruce beetle activity through much of the Region and predominately dry conditions remain, stressing high-elevation mixed-conifer forests. We continued to assess spruce beetle activity around Guanella Pass and the northeastern section of Mount Evans Wilderness through ground observations, plot establishment, and trapping. Spruce beetle has been observed outside of the windthrow areas in standing live trees. We will continue monitoring for emerging beetle populations.

Tree mortality associated with mountain pine beetle (MPB) continued to decline throughout Colorado and is now considered to be at endemic levels. MPB activity was mapped on only 147 acres on the ARNF; most of the mortality was observed in isolated pockets of lodgepole and ponderosa pine. No MPB mortality was observed in five-needled pine on the ARNF in 2016.

Dwarf mistletoes are common and damage lodgepole, limber, and ponderosa pine to varying degrees forest-wide. A great opportunity exists for managing and reducing the disease impacts while the forest conducts vegetation management in campgrounds, administrative areas, and in the forest following the bark beetle epidemic. A dwarf mistletoe management guide is available for the Region (see “Useful Links” section).

White pine blister rust (WPBR) continues to spread and intensify in limber pine in northern Colorado but the disease has not been detected on the Arapaho NF. An extensive study of limber pine tree and regeneration health in the Region found only half of all mature limber pines were healthy (Cleaver et al. 2015, Cleaver et al. 2016). Most declining and dying trees were infected with WPBR and 18% have been killed by MPB. Regeneration is common but density is variable and WPBR impacts were evident on regeneration in 30% of all plots (Cleaver et al. 2016). We established a network of long-term monitoring plots in 2006 to evaluate limber pine health over time (Fig. 1).

Proactive intervention will be needed on sites with low regeneration density or high WPBR infection levels to sustain the species on the landscape. We are working with Rocky Mountain Research Station (RMRS) to develop a conservation strategy for limber pine (Schoettle et al. *in press*) and we continue to explore and exploit resistance in pine populations through breeding and natural selection.

Aerial Detection Survey Highlights

- Spruce beetle activity decreased in Colorado and southern Wyoming from 410,000 acres in 2015 to 350,000 in 2016. A large portion of the damage was in southern Colorado, particularly on the Rio Grande (93,000), Gunnison (72,000), San Isabel (46,000), San Juan (36,000), and Uncompahgre (16,000) National Forests. In northern Colorado, spruce beetle-caused mortality was concentrated in and around RMNP in Grand (18,000), Larimer (22,000), and Jackson (7,000) counties.
- MPB activity decreased to 1,500 acres in 2016 in Colorado and southern Wyoming and is considered to be at endemic levels in most areas.
- Subalpine fir mortality attributed to western balsam bark beetle often in combination with Armillaria root disease affected 128,000 acres in Colorado and southern Wyoming in 2016 and 40,000 acres was mapped on the ARNF. Western balsam bark beetle infestations were widespread and fairly chronic but unlike MPB and spruce beetle, resulting tree mortality is not usually uniform across the landscape, although cumulative mortality over years can result in extensive landscape mortality.

FHP Projects

- FHP staff supports the application of chemical sprays only where MPB activity continues to threaten resources of significant value. Spraying is no longer warranted in most sites on the ARNF.
- FHP staff continued to assess spruce blowdown on Guanella Pass and Mount Evans for developing spruce beetle populations. Spruce beetle was observed in standing live trees on the perimeter of the blowdown in the fall of 2016. Additional monitoring and detection efforts will occur in 2017.
- Portions of the ARNF were included in the CFLR site visit field trips conducted in August of 2016 and showcased cooperative forest health partnerships and activities.
- Recreation sites on the Canyon Lakes Ranger District near Red Feather Lakes were assessed for insect and disease concerns.
- The USFS (RMRS, Dorena Genetic Resource Center, and FHP) and the National Park Service are actively collaborating to identify WPBR resistance in limber and bristlecone pine families in the Region. A high level of resistance has been confirmed in some families on the ARNF (Schoettle et al. 2014). We continue to actively protect trees with confirmed resistance from MPB on the Boulder and Canyon Lakes Ranger Districts by applying the anti-aggregation pheromone verbenone.

- The Southern Rockies Rust Resistance Trial (SRRRT) was initiated at a revitalized CCC nursery on the Medicine Bow NF in 2013 to field-verify WPBR resistance. Seed from resistant limber and Rocky Mountain bristlecone pine trees (tested and confirmed in OR) from throughout the southern Rockies, including trees from the ARNF, was sown and seedlings grown at the Colorado State Forest Service (CSFS) Nursery. Over 700 seedlings were out-planted in fall 2013 and another 700 seedlings in spring 2014. In 2016, seedling growth and health status were assessed; naturally occurring rust infections were identified on some seedlings.
- Restoration planting options and a conservation strategy have been developed for limber pine in the southern Rocky Mountains (Casper et al. 2016, Schoettle et al. In press).
- A study to evaluate the efficacy of pruning limber pine to reduce WPBR impacts was recently completed. Pruning is viable management option for some high-value trees and guidelines are available (Jacobi et al. 2016).
- In 2016, FHP and Colorado State University remeasured 80 long-term monitoring plots, including 10 in the ARNF, to assess limber pine health following the MPB epidemic in the Rocky Mountains (Fig. 1). A 10-year report will be available in the future.
- USDA Forest Service (RMRS, FHP, WWETAC), NPS, and Alberta Government are collaborating on a range-wide limber pine common garden study to quantify variation in WPBR resistance, growth traits, and their relationships to climate (Fig. 2). Many ARNF seed sources are included in this study.
- The Armillaria root disease pathogen, *Armillaria sinapina*, was reported for the first time in Colorado, including isolates collected from recently killed subalpine firs on the Roosevelt National Forest (Burns et al. 2016). Previous surveys in Colorado only identified *A. ostoyae* in the state. Although *A. sinapina* is frequently considered a weak pathogen, trees that are maladapted due to climate change could become more susceptible to Armillaria root disease caused by *A. sinapina*.
- We developed an App (Survey123 for ArcGIS) for collecting hazard tree assessment data on smart phones and tablets. A Hazard Tree Management Guide for Region 2 will be available soon (Blodgett et al. in prep). Contact Kelly Burns for more information.

Surrounding Area Conditions of Note

- RMNP continued to manage high-value, high-risk pines predominately near historic structures and campgrounds with carbaryl or verbenone to prevent MPB activity.
- Douglas-fir tussock moth activity was only recorded on 30 acres in Douglas County, CO. A USFS and CSFS joint assessment of the impact of DFTM is ongoing.
- Emerald ash borer, a federal regulated pest, has been detected in the city of Boulder, CO and other communities within Boulder County. Boulder County is under quarantine for the movement of ash material and all hardwood firewood that does not meet treatment standards outlined in the quarantine rules.

Recent Reports and Resource List

FHP, in cooperation with CSFS, Wyoming State Forestry, and other partners, compiles a Forest Pest Conditions report for the Region each year. FHP also conducts annual Aerial Detection Surveys, ground surveys, special projects, and site visits to identify, assess, and map insect and disease-caused tree mortality and damage and to provide technical assistance to our cooperators throughout the Region. The following is a list of recent reports, publications, and other resources available.

Service Trip Reports

- Kruse JJ, Burns KS. 2016. Assessment of Moffat Stewardship Site, Arapaho National Forest, LSC-16-05.
- Stephens SS, Powell RL, Burns KS, Dell I. 2016. Evaluation of FY15 bark beetle projects, the limber pine conservation program, and other forest health issues in Rocky Mountain National Park and recommendations for FY16, LSC-16-03.
- Stephens SS, Powell RL. 2016. Evaluation of recreation sites on the Canyon Lakes Ranger District for forest insect and disease issues, LSC-16-11.

Publications

- Bergdahl AD, Hill A, tech. coords. 2016. Diseases of trees in the Great Plains. Gen. Tech. Rep. RMRS-GTR-335. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 229 p.
- Blodgett JT, Burns KS, Worrall JW. In prep. Guide to Hazard Tree Management.
- Burns KS, Hanna JW, Klopfenstein NB, Kim MS. 2016. First report of the Armillaria root disease pathogen, *Armillaria sinapina*, on subalpine fir (*Abies lasiocarpa*) and quaking aspen (*Populus tremuloides*) in Colorado. Plant Disease. 100 (1): 217.
- Casper AM, Jacobi WR, Schoettle AW, Burns KS. 2016. Restoration planting options for limber pine in the Southern Rockies. J. Torrey Bot. Soc. 143(1): 21-37.
- Cleaver CM, Jacobi WR, Burns KS, Means RE. 2015. Limber pine in the central and southern Rocky Mountains: Stand conditions and interactions with blister rust, mistletoe, and bark beetles. Forest Ecology and Management 358: 139-153.
- Cleaver CM, Jacobi WR, Burns KS, Means RE. 2016. Limber pine regeneration and white pine blister rust in the central and southern Rocky Mountains. For. Sci. 62(0):000-000.
- Jacobi WR, Bovin PP, Burns KS, Crump A, Goodrich BA. 2016. Pruning limber pine to reduce impacts from white pine blister rust in the southern Rocky Mountains. For. Sci. 62(0):000–000.
- Schoettle AW, Cleaver CM, Burns KS, Connor J. In press. Limber pine conservation strategy for the greater Rocky Mountain National Park area. USDA Forest Service, RMRS-GTR-xxx.
- Schoettle AW, Sniezko RA, Kegley A, Burns KS. 2014. White pine blister rust resistance in limber pine: evidence for a major gene. Phytopathology 104: 163-173.

Useful Links

- R2 Forest Health Protection Website
  - Aerial Survey Data and Maps
  - Dwarf Mistletoes: Ecology and Management in the Rocky Mountain Region
  - Field Guide to Insects and Diseases in the Rocky Mountain Region
  - Hazard Tree Identification and Management
  - Diseases of Trees in the Great Plains
  - Other Reports and Publications
- Forest Health Technology Enterprise Team
  - National Insect and Disease Risk Map
  - National Forest Damage Agent Range Maps
  - Forest Conditions - FHP Mapping and Reporting Tools

We look forward to continued work with the ARNF regarding your forest health concerns. Please do not hesitate to contact us with your inquiries.

Lakewood Service Center

- Jim Kruse, Service Center Leader, jkruse@fs.fed.us, 303-236-9541
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- Rebecca Powell, Entomologist, rebeccalpowell@fs.fed.us, 303-236-8008
- Kelly Burns, Pathologist, ksburns@fs.fed.us, 303-236-8006
- Amy Chambers, Biological Technician, amychambers@fs.fed.us, 303-236-8053

Appendix

Figures

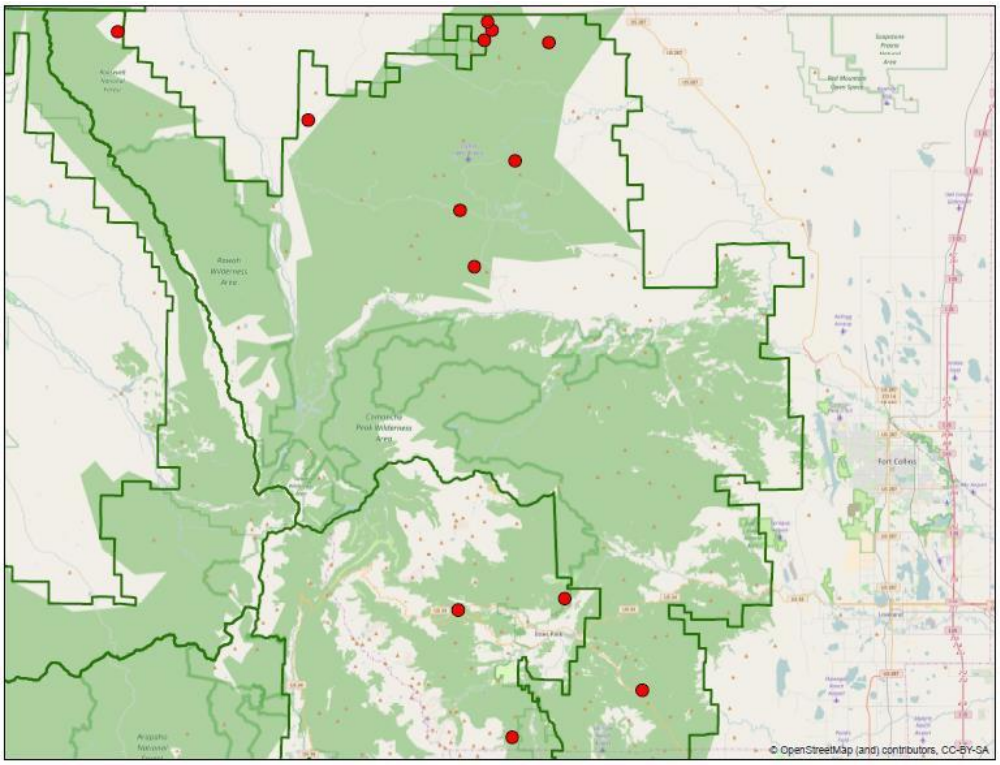

Figure 1. Location of long-term limber pine health monitoring plots in northern Colorado, including 10 on the ARNF. A 10-yr measurement was completed in 2016 and a report will be available in the future.

Figure 2. A range-wide limber pine common garden study was established at the CSFS Nursery last fall. The study will quantify variation in WPBR resistance, growth traits, and their relationships to climate. Many ARNF seed sources are included in this study.

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2016 Forest Health Highlights: Bighorn National Forest

Kurt Allen, Entomologist
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- Western balsam bark beetle killed varying amounts of subalpine fir on an estimated 4,000 acres in 2016 (**Fig. 1 & 4**). In other National Forests in the Rocky Mountain Region, Armillaria root disease contributes to subalpine fir mortally, but it has not been detected in subalpine fir in the Bighorn National Forest.

Figures 1, 2, 3, & 4. From left to right, female western balsam bark beetle, western balsam bark beetle in its gallery, recent western balsam bark beetle damage, and older western balsam bark beetle stand damage. Photos by K. Schotzko.

- Overall, detection of mountain pine beetle-caused mortality of pines increased by over 500 acres in the past year. In 2016, a total of roughly 580 acres were affected by mountain pine beetle, of which 290 acres were lodgepole pine, 2 acres were ponderosa pine, and an additional 290 acres were 5-needle pines (**Fig. 9**).

- Spruce beetle activity has increased since 2015, from 70 acres to 160 acres affected in 2016.

- Douglas-fir beetle caused mortality levels are currently low, and in 2016 only six acres were detected (**Fig. 5 - 7**).



Figures 5 - 7. From left to right, an old Douglas-fir beetle gallery in a dead Douglas-fir, a stand of old Douglas-fir mortality caused by Douglas-fir beetles, and fresh frass accumulating at the base of a Douglas-fir recently attacked by Douglas-fir beetle. (Photos by K. Schotzko).

- Within aspen stands, only five acres were detected by aerial survey with dieback and mortality and no notable defoliation was observed. Sooty bark canker, followed by Cytospora canker, are typically the most damaging agents in aspen stands. White mottled rot is damaging in select aspen stands.

- Dwarf mistletoe continues to be a problem in lodgepole pine stands, but suppression treatments are improving stand conditions or regenerating new uninfected stands.

- White pine blister rust disease is found in most limber pines stands throughout the forest and continues to spread and intensify. Limber pine mortality is especially notable in Ten Sleep and Shell Canyons of Wyoming.

Figure 8. Vista in the Bighorn National Forest with an aspen stand in the foreground. (Photo by K. Schotzko.)

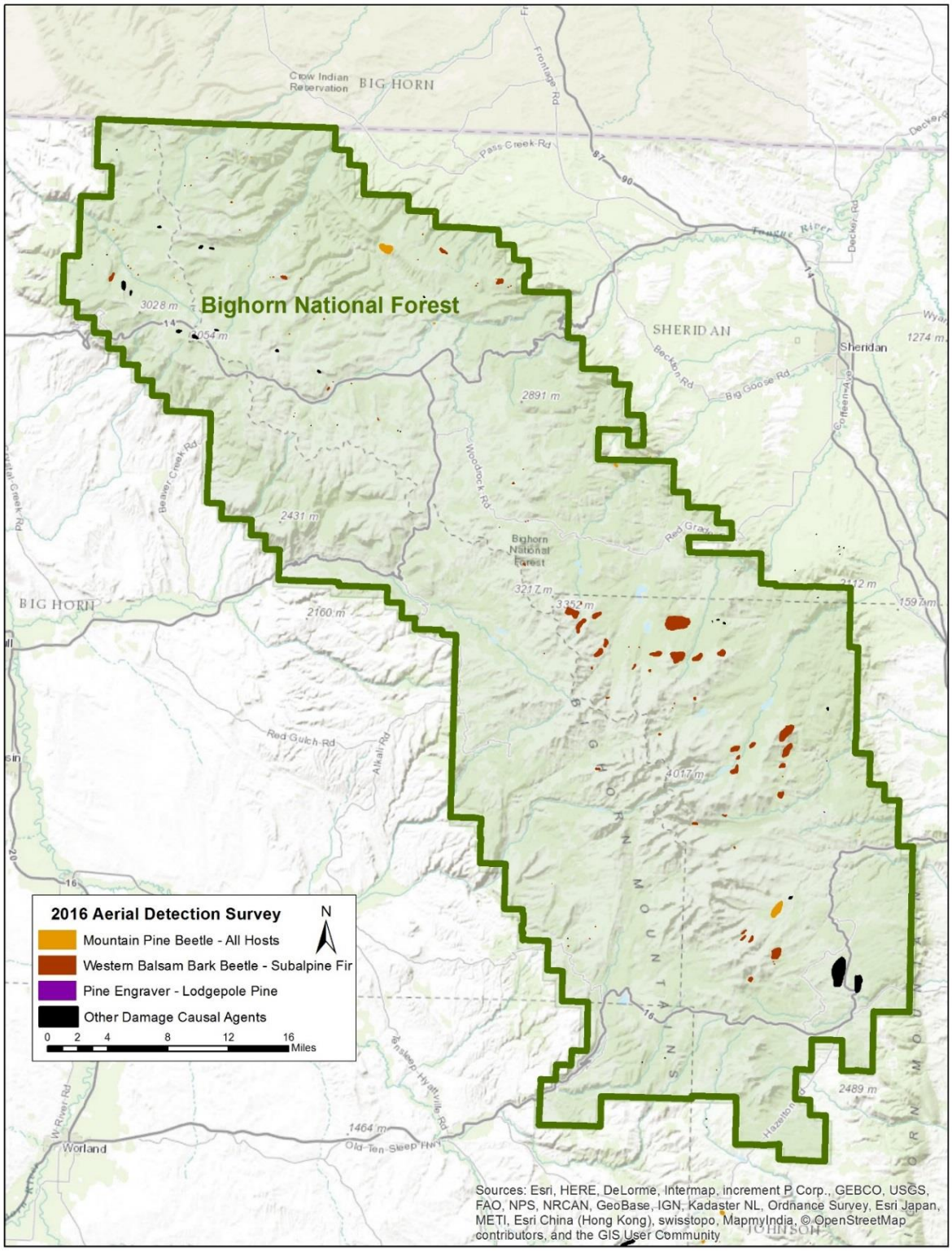

Figure 9. Aerial detection survey map of the Bighorn National Forest: 2016.

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2017 FOREST HEALTH HIGHLIGHTS: BLACK HILLS NATIONAL FOREST

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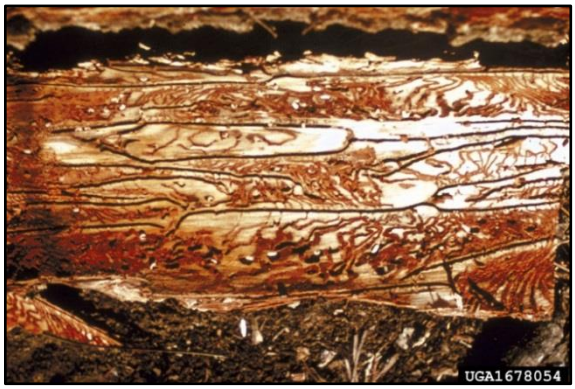
- Mountain pine beetle continues to be the most frequent damage agent found across the forest, with 2,400 acres killed in 2016 compared to 16,000 killed in 2015 (**Fig. 4**). These numbers are taken from remote sensing techniques which are a year behind where the beetles are. Based on 2016 ground surveys done in the fall, mountain pine beetle-caused mortality of ponderosa pine will continue to decline in 2017. It appears the mountain pine beetle epidemic in the Black Hills has subsided, and that populations have returned to endemic levels. Preventive spraying of high value trees in campgrounds and landscape level thinning of forest stands have provided protection to remaining trees where these treatments were implemented (**Fig. 1**).

Figure 1. Stands affected by mountain pine beetle in the Black Hills National Forest.

- Wood borer numbers have been high over the past few years, largely due to high levels of dead trees created by recent mountain pine beetle mortality. Borers do not attack live trees and actually compete with mountain pine beetles in infested trees for the same food resource.
- Pine engraver beetles (*Ips* spp.) are frequently found throughout the forest (**Fig. 2**). These beetles often attack trees simultaneously with mountain pine beetle in addition to attacking other stressed or weakened trees. Mortality caused by engravers appeared to be increasing this past year, with many larger spots of mortality occurring, particularly on the Wyoming portion of the forest.



Figures 2 & 3. *Ips* galleries (left) and Diplodia shoot blight and canker disease (right). [Photos by D. McComb (right) and S. Hagle (left), USDA Forest Service, Bugwood.]

- Diplodia shoot blight and canker disease produced scattered branch mortality in crowns and some tree mortality of ponderosa pine throughout the forest (**Fig. 3**). More extensive branch mortality with some tree mortality was observed in the Northern Hills District. This disease can cause tree mortality, but repeated outbreaks are often required.

- Sooty bark canker continues to be the most damaging agent in aspen stands, followed by Cytospora canker and bronze poplar borer. White mottled rot is damaging in select aspen stands.

- White pine blister rust, an invasive fungal disease, recently killed three of the now 28 known live limber pine (*Pinus flexilis*) on USDA-Forest Service land (on and near Black Elk Peak). Six of the trees were infected with the rust, but infected branches were removed from four trees. Two trees have stem cankers that cannot be removed. Only two trees are large enough to be infested by mountain pine beetle. Verbenone pouches are being applied to protect the larger trees.

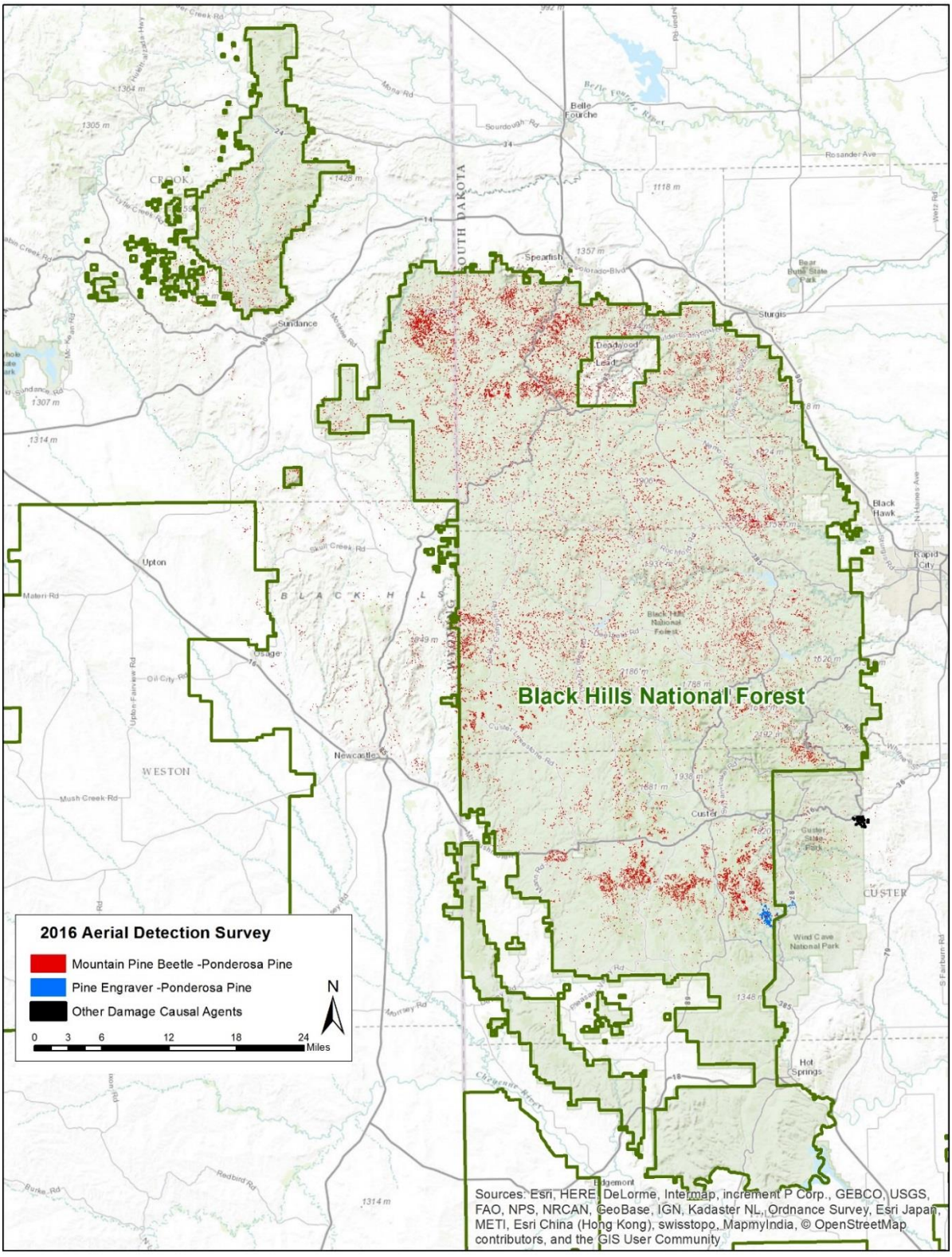


Figure 4. Aerial Photo Interpretation map of the Black Hills National Forest, 2016.

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2016 Forest Insect and Disease Conditions for the Grand Mesa, Uncompahgre, and Gunnison National Forests

USDA Forest Service
Rocky Mountain Region
Forest Health Protection
Gunnison Service Center
216 N. Colorado St.
Gunnison, CO 81230

Overview

The Grand Mesa, Uncompahgre, and Gunnison National Forests (GMUG) currently face several serious forest health issues. Among those that go through dramatic cycles, causing conspicuous damage in 'boom' phases followed by quiescent 'bust' phases, are spruce beetle and western spruce budworm. Several diseases cause more persistent, widespread damage, including root diseases and dwarf mistletoes.

Spruce beetle (*Dendroctonus rufipennis*) activity on the GMUG NFs in recent years has been widespread, and in some areas, very intense. In 2016, mortality from spruce beetle was detected on 91,000 acres and the epidemic spread into 39,000 new acres not previously mapped. The Grand Mesa NF had only 1,000 new acres of spruce beetle activity detected. The Uncompahgre NF had 8,000 new acres, but overall active acres are down from 23,000 in 2015 to 16,000 in 2016. The Gunnison NF had more new acres, 30,000, but the expansion of the epidemic slowed from 46,000 new acres in 2015. In addition to Engelmann spruce being killed by spruce beetle, lodgepole pine has also been killed. Although a small acreage (1,200) on the Gunnison NF, it is an interesting phenomenon (Figure 2).

Virtually all major portions of the Gunnison NF with mature spruce have now been impacted to some degree. Areas currently affected are Monarch Pass in the east, south through the Cochetopa Hills and Los Piños, continuing through the Lake City area, and then westward to the Alpine Plateau and Cimarron Ridge on the Uncompahgre NF. North of Monarch Pass, the western portion of the Collegiate Range is more recently affected. The beetles are also widespread on the east side of the West Elk Wilderness.

The situation on the Grand Mesa NF is somewhat different. Although spruce beetle has been active here for a decade, mortality is much more dispersed. This area experienced a large outbreak in the 1950's which might account for pockets of mortality instead of widespread mass mortality, like the Rio Grande and parts of the Gunnison have experienced.

Management efforts, primarily sanitation activities, can affect spruce beetle populations at a very local level. Sanitation is recommended when possible; otherwise salvage offers the opportunity to capture value and reduce hazards from dead standing trees on the GMUG NFs.

Western spruce budworm (*Choristoneura freemani*): The GMUG had 16,100 defoliated acres detected in 2016, compared to 11,400 in 2015. Area of defoliation increased considerably on the Gunnison NF from 3,200 new acres in 2015 to 9,700 in 2016. The primary hosts of western spruce budworm are Douglas-fir, subalpine fir, white fir, and to a lesser extent, Engelmann spruce. Significant impacts can occur in both mixed conifer and spruce-fir forest types. Feeding by this insect can cause growth loss, top-killing, and tree mortality, especially on suppressed trees. A combination of suitable habitat and favorable weather patterns have resulted in the current widespread outbreak in Colorado. Stand conditions contribute greatly to outbreaks. Reduced fire frequency allows shade-tolerant white fir and Douglas-fir to increase in mixed conifer stands, improving habitat for western spruce budworm. Multistory stands of shade-tolerant species favor western spruce budworm survival as larvae disperse from overstory trees. Management activities such as reducing basal area, favoring pines or aspen where possible, and thinning from below can render stands less susceptible to damage from western spruce budworm.

Douglas-fir beetle (*Dendroctonus pseudotsugae*) is currently at a moderate level on the GMUG. Only 3,500 acres of mortality were mapped in 2016. Of these, 2,000 were new, primarily on the Gunnison NF. Mortality caused by Douglas-fir beetle tends to be dispersed, although there can be concentrated groups of mortality within a generally affected area. Current activity includes portions of the Uncompahgre NF mountain division and the West Elks and Sawatch Range of the Gunnison NF. Several projects have utilized the anti-aggregation pheromone MCH to reduce Douglas-fir beetle impacts in high-value stands on the Forest. Funding provided by Forest Health Protection is being used to purchase and apply MCH to protect Douglas-fir in recreation and viewshed areas in cooperation with District personnel. Douglas-fir beetle may increase in areas where stress from repeated defoliation by western spruce budworm makes Douglas-fir more vulnerable to bark beetle attack.

Subalpine fir mortality declined on the GMUG from 11,700 acres in 2015 to 6,700 acres in 2016, but is still important in the West Elks, on the Grand Mesa, and on the Alpine Plateau and Uncompahgre Plateau (Figure 1). It has occurred fairly consistently in large areas across the Region for over a decade. It is generally caused by **western balsam bark beetle** (*Dryocoetes confusus*) and **Armillaria root disease** (caused by *Armillaria* spp.). Typically, the beetles attack and kill subalpine fir with root disease. The resulting brood may attack neighboring, uninfected trees. It is also not unusual to find trees killed by root disease that are not attacked by the beetle. The relative contribution of the beetle and the fungus to tree mortality is difficult to determine, and can vary over time and among localities.

Where white fir occurs, primarily in the area around Ouray, two organisms cause considerable damage, **fir engraver** (*Scolytus ventralis*) and *Heterobasidion occidentale*, which causes **annosus root disease**. White fir has become more prevalent due to past selective harvesting of ponderosa pine and Douglas-fir as well as fire exclusion. Because white fir is shade-tolerant, it can invade understories of other cover types. It is very intolerant of fire at any age, but in the absence of fire, it can spread and become denser. It is replaced by more white fir, and the susceptible host becomes more widespread and increasingly dominant. The severity of this

insect and disease around Ouray is likely outside the natural range of variability due to both fire exclusion and past harvesting practices. Area of fir engraver activity in 2016 was half what it was in 2015, but it remains to be seen if this is the start of a downward trend.

Armillaria root disease is widespread on the GMUG. It is ecologically important in spruce-fir stands, infecting both Engelmann spruce and subalpine fir. As described above, infected subalpine fir is often attacked by western balsam bark beetle, and is usually killed while standing. Engelmann spruce more often falls due to decayed roots while still green. Infected spruce may serve as hosts for spruce beetle during non-epidemic conditions, and strip attacks can be found above infected roots. When infected spruce fall (windthrow), they can lead to increases in spruce beetle populations. The disease generally intensifies as stands mature.

Dwarf mistletoes cause significant growth loss, and over time can substantially impact forest productivity. Mortality can result when infestations are severe. The most important dwarf mistletoe on the GMUG is **lodgepole pine dwarf mistletoe** (*Arceuthobium americanum*). Even more than annosus root disease, dwarf mistletoe in lodgepole pine is closely related to fire. Stand-replacing fire is a natural regulator of the disease. Fire exclusion has led to increased spread and intensification of dwarf mistletoe. In the absence of stand-replacing fire, silviculture can be used to regulate the disease. Forest management activities that do not address dwarf mistletoe usually increase abundance and severity, so it is important to carefully consider dwarf mistletoe in management plans.

Needle casts of lodgepole pine were very widespread and conspicuous on the Gunnison NF in 2016. Aerial survey detected 2,300 acres, much more than usual. Typically, much more area is infested than is detected from the air. Except in very susceptible populations, damage is often concentrated in lower crowns and small trees where it cannot be seen from the air, and flights may not occur during the time of year when discoloration is most conspicuous.

Two *Lophodermella* species commonly cause needle cast in our lodgepole pine: *L. concolor* and *L. montivaga*. These diseases are widespread and can usually be found killing foliage in many stands. In some areas they are chronically severe, limiting growth, thinning crowns, and killing trees in the understory. The pathogens infect current-year needles of lodgepole pine, causing discoloration, then needle loss in the second year. The severity of these diseases vary from year to year, probably due to weather during or following bud break in the previous year, when sporulation and infection occur.

In 2015, the GMUG experienced an epidemic of **Marssonina leaf blight** of aspen that may have been unprecedented. Over 35,000 acres were mapped with discoloration and defoliation due to the disease (ink spot also contributed to a lesser extent). In 2016, damage dropped to 2,900 acres. This disease tends to vary with spring and summer moisture, but the high populations that developed in 2015 have also carried into 2016. Marssonina leaf blight discolors foliage, then causes defoliation in midsummer. Mortality can occur if trees are heavily infected in several consecutive years.

Aerial Survey Highlights

Table 1. **Grand Mesa National Forest**: acres of major damage agents detected in aerial survey. [a]

Agent	2015 Acres Affected	2016 Acres Affected	1996-2016 Cumulative Acres Affected	2016 New Acres Affected [b]
Spruce beetle	*2,100*	*3,000*	*62,000*	*1,000*
Subalpine fir mortality	*2,200*	*1,000*		
Aspen discoloration	*5,200*	*380*		
Western spruce budworm	*0*	*310*		
Douglas-fir beetle	*3*	*40*	*2,400*	*100*
Aspen defoliation	*2,700*	*20*		
Mountain pine beetle	*0*	*0*	*20*	*0*

[a] Due to the nature of aerial surveys, these data will only provide rough estimates of location, intensity and the resulting trend information for agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The data presented should only be used as a partial indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent. Using these data for purposes other than those for which it was intended may yield inaccurate or misleading results.

Table 2. Uncompahgre National Forest: acres of major damage agents detected in aerial survey.

Agent	2015 Acres Affected	2016 Acres Affected	1996-2016 Cumulative Acres Affected	2016 New Acres Affected
Spruce beetle	*23,000*	*16,000*	*40,000*	*8,000*
Western spruce budworm	*8,200*	*6,000*		
Fir engraver	*5,600*	*2,800*		
Subalpine fir mortality	*1,500*	*1,800*		
Aspen defoliation	*6,300*	*1,800*		
Douglas-fir beetle	*380*	*880*	*31,000*	*0*
Aspen discoloration	*2,300*	*30*		
Mountain pine beetle	*0*	*0*	*11,000*	*0*

Table 3. **Gunnison National Forest**: acres of major damage agents detected in aerial survey.

Agent	2015 Acres Affected	2016 Acres Affected	1996-2016 Cumulative Acres Affected	2016 New Acres Affected
Spruce beetle	*75,000*	*72,000*	*226,000*	*30,000*
Western spruce budworm	*3,200*	*9,700*		
Subalpine fir mortality	*8,000*	*3,900*		
Douglas-fir beetle	*1,800*	*2,600*	*28,000*	*2,000*
Lophodermella needle cast	*222*	*2,300*		
Aspen discoloration	*16,000*	*940*		
Aspen defoliation	*2,900*	*680*		
Aspen dieback and mortality	*0*	*40*		
Fir engraver	*0*	*61*		
Mountain pine beetle	*600*	*0*	*6,100*	*0*

- Since 1996, spruce beetle has affected 1,715,000 acres in Colorado. The GMUG had 91,000 acres of active spruce beetle activity in 2016, of which 39,000 acres were newly reported.
- Defoliation by western spruce budworm was detected in Colorado on 226,000 acres in 2016, compared to 312,000 acres in 2015. It still remains abundant on many southern Colorado forests.

FHP Projects

- The Southwestern Colorado Bioclimate Project projects climate change impacts on tree species to aid forest adaptation efforts on the SJNF, RGNF, GMUG, Southern Ute Indian Tribe, Tres Rios BLM, and Mesa Verde National Park. Rocky Mountain Research Station is developing adaptation management recommendations based on the projections. We hope to hold a workshop for participants this spring.

Recent Reports and Resources

Forest Health Protection (FHP), in cooperation with the Colorado State Forest Service, conducts an annual aerial forest health survey, ground surveys, and site visits to identify, assess, and map forest damage due to diseases and insects throughout the Region. The following is a list of recent reports and resources available.

- Service Trip Report GSC-17-02, Spruce beetle trap trees, Hay Park Salvage Sale, Grand Mesa, January 2017.
- Technical Report R2-68. 2016. Bioclimate Models and Change Projections to Inform Forest Adaptation in Southwestern Colorado: Interim Report. Worrall JJ, Marchetti SB, Rehfeldt GE. Golden, Colorado: Forest Health Protection, State and Private Forestry and Tribal Relations,

Rocky Mountain Region, US Forest Service.
http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd500723.pdf.
This report is part of the Southwestern Colorado Bioclimate Project, described above.

- Dwarf Mistletoes: Ecology and Management in the Rocky Mountain Region
- Forest Health Protection
    - Other Forest Condition Reports
    - Other Regional Reports
    - Aerial Detection Survey
        - Shapefiles
        - Data tables by state, county, and forest available by request
    - Mapping and Reporting
- Forest Health Technology Enterprise Team
    - Risk Map
    - National Forest damage Agent Range Maps
    - Forest Pest Conditions

We look forward to continued work with the GMUG regarding your forest disease and insect concerns. Please do not hesitate to contact us with your questions.

Gunnison Service Center

- Jim Worrall, Group Leader and Pathologist, jworrall@fs.fed.us, 970-642-4453
- Amy Lockner, Entomologist, alockner@fs.fed.us, 970-642-4448
- Suzanne Marchetti, Biological Science Technician, sbmarchetti@fs.fed.us, 970-642-4446

Figure 1. Damage detected in 2016 aerial detection survey (next page).
Due to the nature of aerial surveys, these data only provide rough estimates of location of agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The data should only be used as a partial indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent.

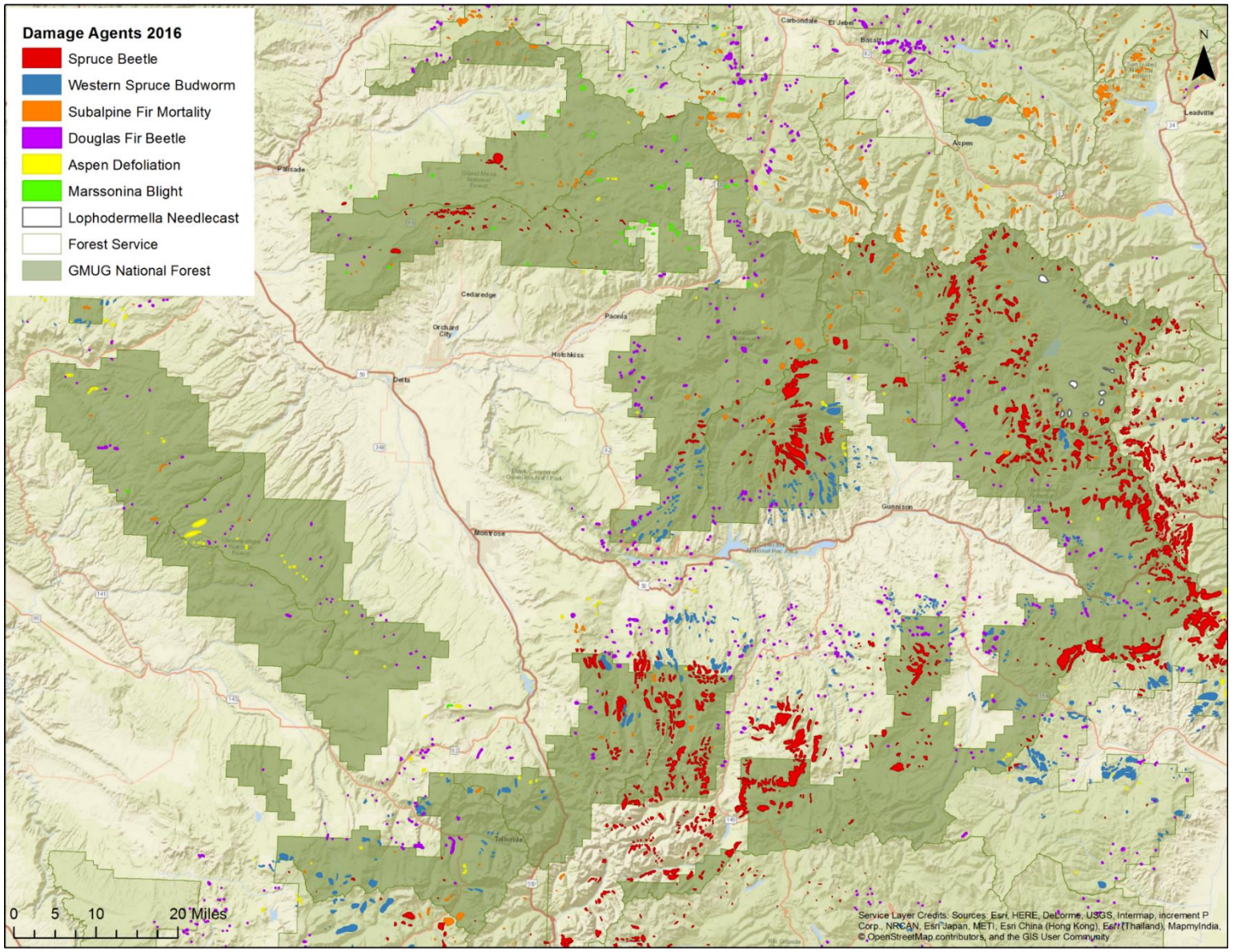
Damage Agents 2016
Spruce Beetle
Western Spruce Budworm
Subalpine Fir Mortality
Douglas Fir Beetle
Aspen Defoliation
Marssonina Blight
Lophodermella Needlecast
Forest Service
GMUG National Forest
N
Carbondale
El Jebel
Basalt
Leadville
Aspen
Palisade
Cedaredge
Orchard City
Paonia
Hotchkiss
Delta
Montrose
Gunnison
Telluride
0 5 10 20 Miles
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 2. Lodgepole pine killed by spruce beetle on the Gunnison NF. (Photo by Justin Backsen).

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2016 Forest Pest Conditions Highlight: Medicine Bow and Routt National Forests

USDA Forest Service
Rocky Mountain
Region Forest Health
Protection Lakewood
Service Center 740
Simms Street
Golden, CO 80401

Conditions Highlights

In 2016, Colorado and southern Wyoming saw a continued decrease in spruce beetle activity. Aerial detection surveys identified 6,040 acres on the Medicine Bow and Routt National Forests (MBRNF). Most of the activity is on the Routt National Forest in Jackson County, CO (7,000 acres). Numerous windthrow events since 2011 have increased the potential for spruce beetle activity through much of the Region and predominately dry conditions continue to stress high-elevation mixed-conifer forests.

Tree mortality caused by mountain pine beetle (MPB) continued to decline throughout Colorado and southern Wyoming and populations are considered to be at endemic levels. Fewer than 100 acres of MPB were observed in 2016 on the MBRNF; all damage occurred in Natrona County, WY.

Dwarf mistletoe is common and impacts occur to varying degrees in lodgepole and limber pine forest-wide. A great opportunity exists for managing and reducing the impacts of this disease while the forest conducts vegetation management in campgrounds, administrative areas, and in the forest following the bark beetle epidemic. A dwarf mistletoe management guide is available for the Region (see “Useful Links” section).

White pine blister rust (WPBR) is well established in limber pine on the Medicine Bow National Forest but has not been detected on the Routt to date. An extensive study of limber pine tree and regeneration health found only half of all mature limber pines were healthy (Cleaver et al. 2015, Cleaver et al. 2016). Most declining and dying trees were infected with WPBR and 18% have been killed by MPB. Regeneration is common but density is variable. WPBR impacts were evident on regeneration in 30% of all plots. FHP established a network of long-term monitoring plots in 2006 to evaluate limber pine health over time (Fig. 1). Proactive intervention will be needed on sites with low regeneration density or high WPBR infection levels to sustain the species on the landscape. We are working with Rocky Mountain Research Station (RMRS) to develop a conservation strategy for limber pine (Schoettle et al. *in press*) and we continue to explore and exploit resistance in pine populations through breeding and natural selection.

Aerial Detection Survey Highlights

- Spruce beetle activity decreased in Colorado and southern Wyoming from 410,000 acres in 2015 to 350,000 acres in 2016. Of this, only 240 and 5,800 acres were affected on the Medicine Bow and Routt National Forests, respectively, in 2016.
- MPB activity in Colorado and southern Wyoming decreased to 1,500 acres in 2016. No damage was reported on the Routt and only 80 acres was reported on the Medicine Bow National Forest.
- Subalpine fir mortality fir was reported on 128,000 acres in Colorado and southern Wyoming in 2016. This included 13,000 acres on the Routt and 4,900 acres on the Medicine Bow. This is generally caused by western balsam bark beetle (*Dryocoetes confusus*) and Armillaria root disease (caused by *Armillaria* spp.). Frequently, the beetle attacks and kills subalpine fir with root disease. The resulting brood may attack neighboring, uninfected trees. The relative contribution of the beetle and the fungus to tree mortality is difficult to determine, and can differ over time and among localities.
- Aspen defoliation was detected on 1500 acres forest-wide (400 on the Medicine Bow and 1100 acres on the Routt). Most of the damage was observed in Routt County, Colorado and Carbon County, Wyoming.

FHP Projects

- FHP staff recommended reassessing the need for chemical spray for individual tree protection and supports spraying only where MPB activity threatens high-value resources. Spraying is no longer warranted in the majority of the MBRNF.
- FHP and RMRS continue to use verbenone (an MPB anti-aggregation pheromone) to protect limber pines with confirmed resistance to WPBR from MPB on the Laramie Ranger District.
- In 2016, FHP and Colorado State University re-measured 80 long-term monitoring plots, including 23 on the MBNF, to assess limber pine health following the MPB epidemic. A 10-year report will be available in the future (Fig. 1).
- The USFS (RMRS, FHP, and Dorena Genetic Resource Center) and the National Park Service are actively collaborating to identify WPBR resistance in limber and bristlecone pine families in the region. A high level of rust resistance has been confirmed in some limber pine families on the MBNF (Schoettle et al. 2014).
- The Southern Rockies Rust Resistance Trial (SRRRT) was initiated at a revitalized CCC nursery on the MBNF in 2013 to field-verify WPBR resistance. Seed from resistant limber and Rocky Mountain bristlecone pines (tested and confirmed in OR) from throughout the southern Rockies, including trees from the MBNF, was sown and seedlings grown at the Colorado State Forest Service Nursery. Over 700 seedlings were out-planted in fall 2013 and another 700 seedlings in spring 2014. In 2016, seedling growth and health status were assessed; naturally occurring rust infections were identified on some seedlings (Fig. 2).

- A study to evaluate the efficacy of pruning to reduce WPBR impacts was recently completed. Study sites included Vedauwoo Campground on the MBNF and Mosca Pass in the Great Sand Dunes National Park and Preserve. Pruning guidelines are available (Jacobi et al. 2016).
- Restoration planting options and a conservation strategy have been developed for limber pine in the southern Rocky Mountains (Casper et al. 2016, Schoettle et al. In press).
- The USDA Forest Service (RMRS, FHP, WWETAC), NPS, and Alberta Government are collaborating on a range-wide limber pine common garden study that will quantify variation in WPBR resistance, growth traits, and their relationships to climate. Many MBRNF seed sources are included in this study.
- FHP developed an App (Survey123 for ArcGIS Online) for collecting hazard tree assessment data on smart phones and tablets and a Hazard Tree Management Guide for Region 2 will be available soon (Blodgett et al. in prep). Contact Kelly Burns for more information.

Surrounding Area Conditions of Note

- Rocky Mountain National Park continues to manage high-value, high-risk pines predominately near historic structures and campgrounds with carbaryl or verbenone to prevent MPB attacks.
- Spruce beetle activity has increased in the northern and western areas of Rocky Mountain National Park.
- Emerald ash borer still has not been confirmed outside of Boulder County. A quarantine is in place for regulated articles, which includes all hardwood firewood, for Boulder County.
- The Armillaria root disease pathogen, *Armillaria sinapina*, was reported for the first time in Colorado, including isolates collected from recently killed subalpine firs on the Roosevelt National Forest (Burns et al. 2016). Previous surveys in Colorado only identified *A. ostoyae* in the state. Although *A. sinapina* is frequently considered a weak pathogen, trees that are maladapted due to climate change could become more susceptible to Armillaria root disease caused by *A. sinapina*.

Recent Reports and Resource List

FHP, in cooperation with the Colorado State Forest Service, Wyoming State Forestry, and other partners, compiles a Forest Pest Conditions report for the Region each year. FHP also conducts annual Aerial Detection Surveys, ground surveys, special projects, and site visits to identify, assess, and map insect and disease-caused tree mortality and damage and to provide technical assistance to our cooperators throughout the Region. The following is a list of recent reports, publications, and other resources available.

Service Trip Reports

- Burns KS, Powell RL, Stephens SS. 2016. Forest Health Conditions in Stand UP0104-0487, Laramie Ranger District, Medicine Bow National Forest, LSC-16-06.

Publications

- Bergdahl AD, Hill A, tech. coords. 2016. Diseases of trees in the Great Plains. Gen. Tech. Rep. RMRS-GTR-335. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 229 p.
- Blodgett JT, Burns KS, Worrall JW. In prep. Guide to Hazard Tree Management.
- Burns KS, Hanna JW, Klopfenstein NB, Kim MS. 2016. First report of the Armillaria root disease pathogen, *Armillaria sinapina*, on subalpine fir (*Abies lasiocarpa*) and quaking aspen (*Populus tremuloides*) in Colorado. Plant Disease. 100 (1): 217.
- Casper AM, Jacobi WR, Schoettle AW, Burns KS. 2016. Restoration planting options for limber pine in the Southern Rockies. J. Torrey Bot. Soc. 143(1): 21-37.
- Cleaver CM, Jacobi WR, Burns KS, Means RE. 2015. Limber pine in the central and southern Rocky Mountains: Stand conditions and interactions with blister rust, mistletoe, and bark beetles. Forest Ecology and Management 358: 139-153.
- Cleaver CM, Jacobi WR, Burns KS, Means RE. 2016. Limber pine regeneration and white pine blister rust in the central and southern Rocky Mountains. For. Sci. 62(0):000-000.
- Jacobi WR, Bovin PP, Burns KS, Crump A, Goodrich BA. 2016. Pruning limber pine to reduce impacts from white pine blister rust in the southern Rocky Mountains. For. Sci. 62(0):000–000.
- Schoettle AW, Cleaver CM, Burns KS, Connor J. In press. Limber pine conservation strategy for the greater RMNP area. USDA Forest Service, RMRS-GTR-xxx.
- Schoettle AW, Sniezko RA, Kegley A, Burns KS. 2014. White pine blister rust resistance in limber pine: evidence for a major gene. Phytopathology 104: 163-173.

Useful Links

- R2 Forest Health Protection Website
  - Aerial Survey Data and Maps (reports and tables are available by request)
  - Dwarf Mistletoes: Ecology and Management in the Rocky Mountain Region
  - Field Guide to Insects and Diseases in the Rocky Mountain Region
  - Diseases of Trees in the Great Plains
  - Hazard Tree Identification and Management
  - Other Reports and Publications
- Forest Health Technology Enterprise Team
  - National Insect and Disease Risk Map
  - National Forest Damage Agent Range Maps
  - Forest Conditions - FHP Mapping and Reporting Tools

We look forward to continued work with the MBRNF regarding your forest health concerns. Please do not hesitate to contact us with your inquiries.

Lakewood Service Center

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- Rebecca Powell, Entomologist, rebeccalpowell@fs.fed.us, 303-236-8008
- Kelly Burns, Pathologist, ksburns@fs.fed.us, 303-236-8006
- Amy Chambers, Biological Technician, amychambers@fs.fed.us, 303-236-8053

Appendix

Figures

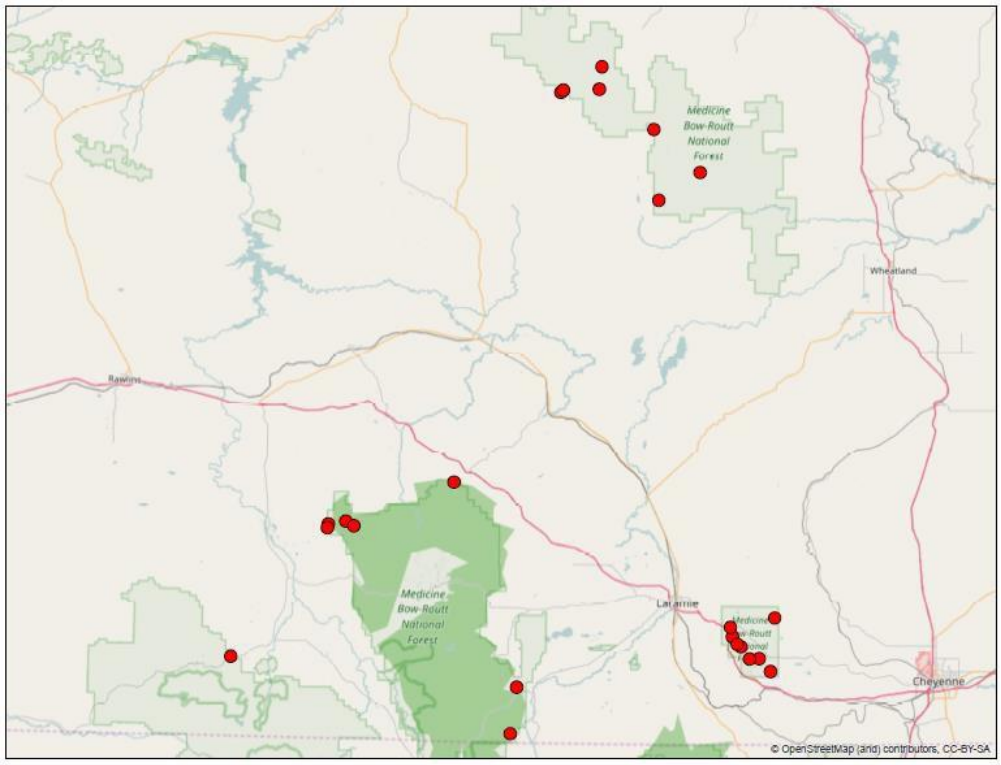

Figure 1. Location of 23 long-term limber pine health monitoring plots on the MBNF. Plots were established in 2006, re-measured in 2016, and a 10-yr report will be available soon.

Figure 2. Seedling health and growth were assessed at the Southern Rockies Rust Resistance Trail last fall. Naturally occurring WPBR infections were identified on some limber pine seedlings. The small orange droplets visible on this twig are pycnia which consist of masses of pycniospores (spermatia) produced by the fungus.

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2016 FOREST HEALTH HIGHLIGHTS: NEBRASKA NATIONAL FOREST

Kurt Allen, Entomologist
Kendra Schotzko, Entomologist
Jim Blodgett, Pathologist
Al Dymerski, Forestry Technician

8221 S Highway 16, Rapid City, SD 57702
Phone: 605-343-1567; kallen@fs.fed.us

- A hail storm passed over the Nebraska National Forest at the end of June 2016, and caused severe damage to many of the ponderosa pine within impacted stands (**Fig. 1 a & b**). Many trees were stripped of their foliage by the hail, or the branches were so damaged by the impact of the hail that the foliage has since died. Mature trees appeared most severely affected, but all size classes showed signs of hail impact. The extent of foliar and branch damage varied, in some patches trees had few discolored needles, while the crowns of trees in adjacent areas were completely red.
- Without prior knowledge of recent weather events, hail damage can appear similar to Diplodia shoot blight and canker disease when observed from a plane during aerial detection surveys. During our aerial surveys, some areas damaged predominantly by hail were recorded as Diplodia shoot blight and canker disease (large areas marked in purple immediately northeast of highway 385 and Antelope Road intersection, south of Chadron) (**Fig. 4**).

- Ponderosa and jack pines that retained healthy foliage after the hail storm may continue to discolor next year if they are infected by Diplodia shoot blight and canker (**Fig. 2 a**). Pines under stress from the hail impacts or secondarily from disease may be attractive and susceptible to pine engraver beetles (**Fig. 2 b**)

Figures 1 a & b. Ponderosa pine affected by hail south of Chadron, NE. (Photos by A. Dymerski).

Pine engraver beetle (*Ips* sp.) combined with fire are the most damaging agents in ponderosa and jack pine. Aerial detection survey identified about 600 acres of pine engraver beetle damage in ponderosa pine in the Pine Ridge Ranger District; other districts were not flown (**Fig. 2 b & 4**).

Figures 2 a & b. Diplodia shoot blight and canker disease (left) and pine engraver *beetle* galleries (right).

- Damage agents in conifers at the nursery include *Diplodia pinea*, *Fusarium*, *Phytophthora*, and *Pythium*; and occasionally *Phomopsis*. Damage agents in hardwoods at the nursery include black-knot and shot hole in *Prunus*; and occasional foliage diseases including Anthracnose; powdery mildews; Melampsora rust on cottonwood; rusts on *Ribes*; and Gymnosporangium rust ("cedar apple rust") on *Amelanchier*, *Malus*, and *Crataegus*.

Figure 3. Fall colors in bur, swamp white, and red oaks at Bessey Nursery. (Photo from K. Allen).

- Diseases at the nursery are controlled with proper watering practices, healthy plants, and timely control applications to reduce significant loss (**Fig. 3**). Animal damage is minimized with deer fence and woven electric fence for small mammals. Weeds at the nursery are being controlled with mowing, hand-pulling, and herbicide to maintain weed free fields as well as wind-breaks.

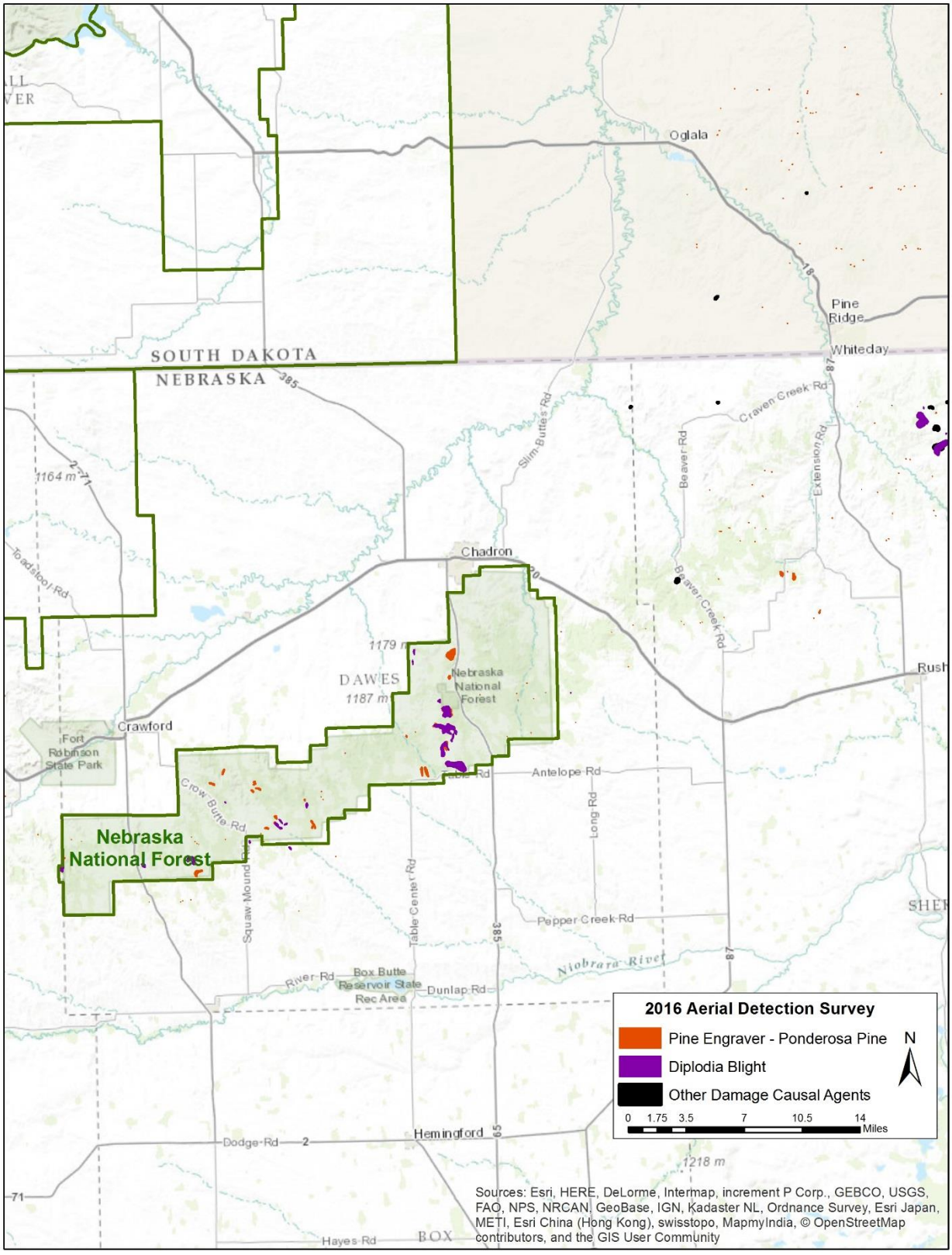

Figure 4. Aerial detection survey map of Nebraska National Forest, 2016.

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2016 Forest Pest Conditions Highlights: Pike National Forest

USDA Forest Service
Rocky Mountain Region
Forest Health Protection
Lakewood Service Center
740 Simms Street
Golden, CO 80401

Conditions Highlights

In 2016 the Pike National Forest (PNF) saw a significant decrease in Douglas-fir tussock moth (DFTM) with only 30 acres in Douglas County impacted after the outbreak collapsed. Western spruce budworm (WSBW) continued to impact 28,000 acres on the PNF. These insects are often observed in the same areas and impacting the same individual trees. Defoliation by DFTM garnered considerable attention from the public in 2015. A joint USFS and Colorado State Forest Service project was initiated in the spring of 2016 to assess defoliation impacts by DFTM across the host type within 50 permanent monitoring plots. The majority of stands included in this study fall on the PNF and include adjacent State and private properties **(see Appendix, Figures 1 and 2, Map 1)**.

Bark beetle activity occurs at largely endemic levels across the PNF with approximately 70 acres of mountain pine beetle and 70 acres of Douglas-fir beetle detected by aerial detection surveys. Douglas-fir beetle is common along the Rampart Range. On July 20th, 2015 a significant wind event caused several acres of blowdown in the Devil's Head area which lead to closure of the trailhead. This area of blowdown may become impacted by insects such as spruce beetle or Douglas-fir beetle which can reproduce in down woody material. FHP deployed MCH, an anti-aggregation pheromone, at Topaz Point and Devil's Head in 2016 and will continue to assist the Forest with monitoring these areas. An increase in spruce beetle activity was detected during a field assessment near the Crags Campground and the adjacent dispersed camping area. Aerial detection surveys reported 2,800 acres of spruce beetle on the PNF, an increase from 470 acres in 2015.

Dwarf mistletoes are one of the most common and damaging diseases of Douglas-fir, lodgepole pine, limber pine, and ponderosa pine on the PNF. A great opportunity exists for managing and reducing the impacts of these diseases while the forest conducts vegetation management in campgrounds, administrative areas, and in the forest following bark beetle outbreaks and other disturbances. A dwarf mistletoe management guide is available for the Region **(see "Useful Links" section)**.

White pine blister rust (WPBR) continues to spread in limber pine on the forest. The disease is well established in the Sangre de Cristo and Wet Mountains but new infection centers were identified near Crystal Reservoir in 2009 and in the Rampart Range in 2013, Pikes Peak Ranger District. The only infected bristlecone pines identified to date are located within the Great Sand Dunes National Park and Preserve. Forest Health Protection and Colorado State University will re-measure 28 long-term monitoring plots, initially established in 2004, in the Sangre de Cristo Mountains during the 2017 field season. Results will enhance our understanding of disease distribution, severity, and impacts in southern Colorado. We are also working with Rocky Mountain Research Station to explore and exploit resistance in limber pine populations through breeding and natural selection.

Aerial Detection Survey Highlights

- Douglas-fir tussock moth activity was only mapped on 30 acres in Colorado in Douglas County; a precipitous drop from 26,000 mapped in 2016.
- Western spruce budworm activity increased on the PNF from 26,000 acres in 2015 to 28,000 in 2016.
- Douglas-fir beetle activity decreased on the PNF from 290 acres in 2015 to 70 acres in 2016.
- Western balsam bark beetle activity on the PNF increased from 3,100 acres in to 5,500 acres in 2016.
- Aspen defoliation, discoloration, and/or dieback and decline were minimal forest-wide.

FHP Projects

- FHP conducted defoliator surveys and trapping across the PNF for WSBW, Pandora moth and DFTM.
- Spruce beetle activity was assessed and management recommendations were provided to the Pikes Peak Ranger District for the Crags Campground area and the dispersed camping area along Fourmile Creek.
- The annual Region 2 Forest Insect and Disease Identification and Management and Hazard Tree Management trainings were held at the Monument Fire Center in June 2016 and included field trips on the PNF.
- The Southern Rockies Rust Resistance Trial (SRRRT) was initiated at a revitalized CCC nursery on the Medicine Bow National Forest in 2013 to field-verify WPBR resistance. Seed from resistant families (tested and confirmed in OR) from throughout the Southern Rockies, including families from the PSINFs, was sown and seedlings grown at the Colorado State Forest Service Nursery. The seedlings are being periodically assessed for signs and symptoms of WPBR.
- FHP collaborated with Colorado State University PhD student, KA Leddy, to remeasure 80 long-term monitoring plots in northern Colorado, Wyoming, and central Montana looking at limber pine health following the mountain pine beetle epidemic. A 10-year report will be available in the future.
- Restoration planting options have been developed (Casper et al. 2016) and a conservation strategy will be available soon (Schoettle et al. in press) for limber pine in the Rocky Mountain Region.
- A study to evaluate the efficacy of pruning limber pine to reduce WPBR impacts was recently completed and pruning guidelines are available (Jacobi et al. 2016).
- The Armillaria root disease pathogen, *Armillaria sinapina*, was reported for the first time in Colorado, including an isolate collected from a diseased subalpine fir on the SINF (Burns et al. 2016). Previous surveys in Colorado only identified *A. solidipes* (as *A*. *ostoyae*) in the state. Although *A*. *sinapina* is frequently considered a weak pathogen, trees that are maladapted due to climate change could become more susceptible to Armillaria root disease caused by *A*. *sinapina*.
- A Survey123 for ArcGIS App is available for collecting hazard tree assessment data on smart phones and tablets and a Hazard Tree Management Guide for Region 2 will be available soon (Blodgett et al. in prep). Contact Kelly Burns for more information.

Surrounding Area Conditions of Note

- U.S. Air Force Academy, including the Farish Recreation Area, has experienced light defoliation from WSBW within stands of Engelmann spruce and Douglas-fir.
- Private properties in and around Perry Park, Foxton, and Buffalo Creek have experienced defoliation by DFTM and WSBW. Land owners have treated some areas with an aerial application of *Bacillus thuringiensis* (Bt), a naturally occurring bacterium, common in some soils, that causes disease in leaf and needle feeding caterpillars.
- A collaborative *Bt* spray project was conducted by the USFS, CSFS and the City of Colorado Springs to mitigate DFTM moth in June, 2016.
- Cytospora canker (*C. kunzei*) was reported for the first time in Rocky Mountain bristlecone pine on the Air Force Academy (see report LSC-17-01). *Cytospora kunzei* is a common canker pathogen of spruce and Douglas-fir in the Rocky Mountain Region. *Cytospora* species are often opportunistic pathogens of stressed or injured plants and therefore could become more prevalent with climate change and increased use of bristlecone pine in ornamental plantings.
- Emerald ash borer, a federal regulated pest, has been detected in the city of Boulder, CO and other communities within Boulder County. Boulder County is under quarantine for the movement of ash material and all hardwood firewood that does not meet treatment standards outlined in the quarantine rules.

Recent Reports and Resource List

Forest Health Protection, in cooperation with the Colorado State Forest Service and other partners, compiles a Forest Pest Conditions Report for Colorado each year. FHP also conducts annual Aerial Detection Surveys, ground surveys, special projects, and site visits to identify, assess, and map insect and disease-caused tree mortality and damage and to provide technical assistance to our cooperators throughout the Region. The following is a list of recent reports, publications, and other resources available and relevant to the PNF. Aerial detection survey tables and reports are available by request.

Service Trip Reports

- Stephens SS, Powell RL. 2016. Spruce beetle site visit to Bear Trap Ranch, LSC-16-01.
- Stephens SS, Powell RL. 2016. Assessment of western spruce budworm and Douglas-fir tussock moth and other forest health issues at the Air Force Academy, LSC-16-02.
- Burns KS, Dell I. 2016. Evaluation of hazard tree issues in the Air Force Academy's Farish Recreation Area, LSC-16-04.
- Stephens SS, Powell RL. 2016. Douglas-fir tussock moth-impacted private property visits with Colorado State Forest Service, LSC-16-07.
- Stephens SS, Powell RL. 2016. Evaluation of Douglas-fir tussock moth-impacted site visits hear Colorado Springs, Colorado, LSC-16-08.
- Stephens SS, Powell RL. 2016. Douglas-fir tussock moth egg mass surveys at North Cheyenne Canyon Park and adjacent Pike National Forest stands, Colorado Springs, Colorado, LSC-16-09.
- Stephens SS, Powell RL. 2016. Evaluation of tussock moth defoliation event at Cheyenne Mountain Air Force Station, LSC-16-10.
- Stephens SS, Powell RL. 2016. Pre-treatment spruce beetle site visit to the Crags, LSC-16-12.
- Burns KS. 2016. Tree health assessments at the Carlton House on the Air Force Academy, LSC-17-01.

Publications

- Bergdahl AD, Hill A, Tech. Coords. 2016. Diseases of trees in the Great Plains. Gen. Tech. Rep. RMRS-GTR-335. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 229 p.
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  - National Insect and Disease Risk Map
  - National Forest Damage Agent Range Maps
  - Forest Conditions - FHP Mapping and Reporting Tools

We look forward to continued work with the PNF regarding your forest health concerns. Please do not hesitate to contact us with your inquiries.

Lakewood Service Center

- Jim Kruse, Service Center Leader, jkruse@fs.fed.us, 303-236-9541
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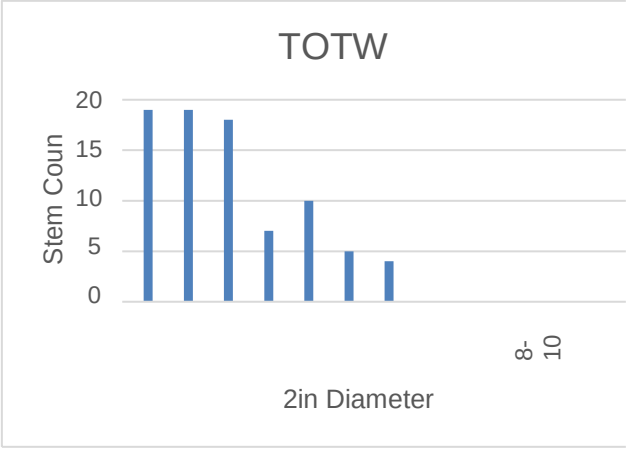
- Rebecca Powell, Entomologist, rebeccalpowell@fs.fed.us, 303-236-8008
- Kelly Burns, Pathologist, ksburns@fs.fed.us, 303-236-8006
- Amy Chambers, Biological Technician, amycambers@fs.fed.us, 303-236-8053

Appendix 1

Photos

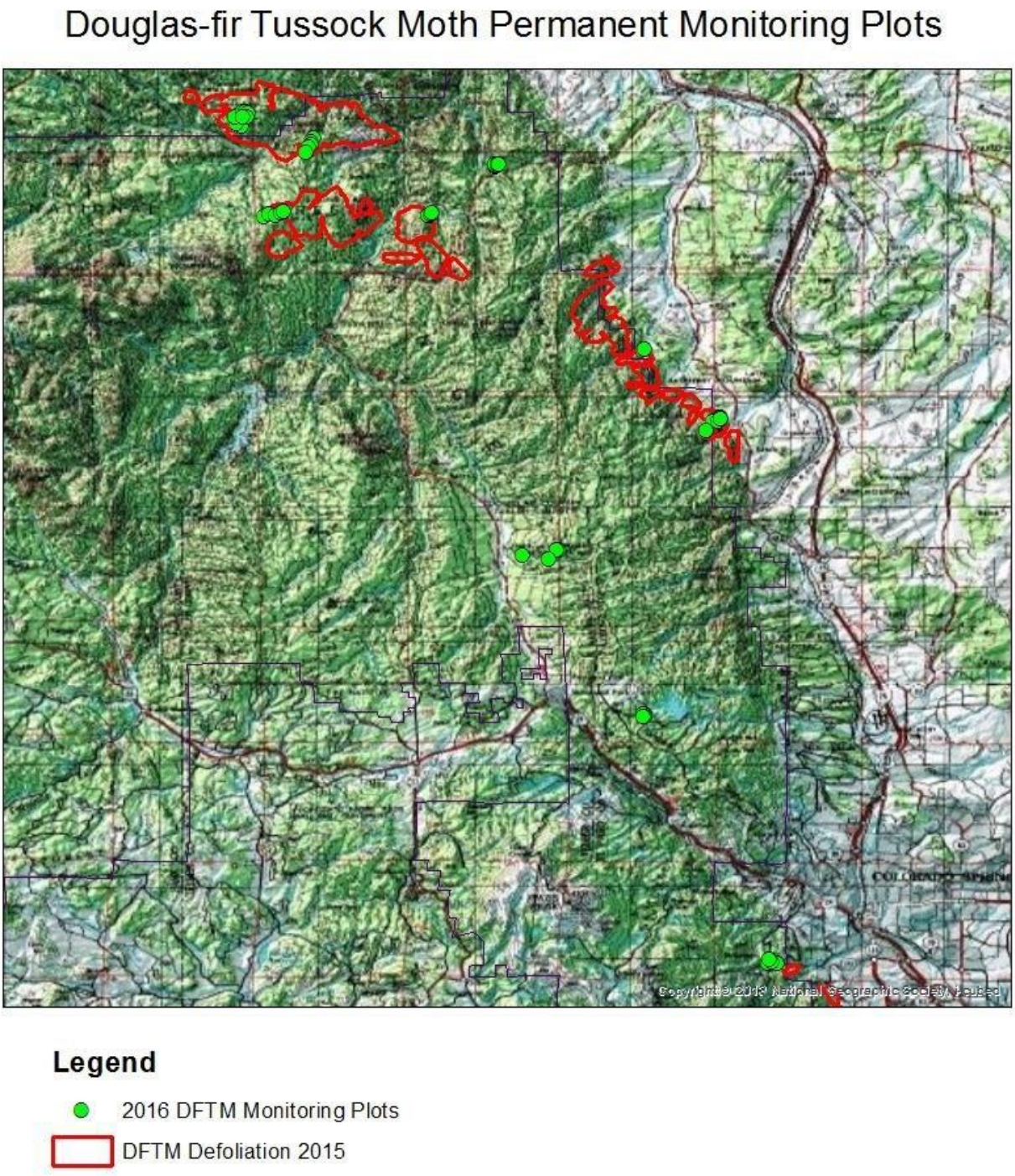
Figure 1. FHP staff evaluate DFTM defoliation at Top of the World (TOTW), South Platte RD, Pike NF following 2015 defoliation.



Host Summary Data Defoliation and Mortality

	DFTM	DFTM	Mortality Post 2015 Defoliatio
Defoliation	92%	0	0

Figure 2. Diameter class distribution for Top of the World site 1 (L) and defoliation and mortality data (R). This is an example of one of the 50 monitoring plots established for DFTM in 2016. In this case very severe defoliation occurred on the site, but resulted in no mortality.



Map 1. Location of Douglas-fir tussock moth monitoring plots established in 2016 and defoliation mapped in 2015 (red polygons). No defoliation was mapped through Aerial Detection Surveys in 2016.

Go to the **Table of Contents** for 2016 Rocky Mountain Region Forest Health Conditions report

2016 Forest Insect and Disease Conditions, Rio Grande National Forest

USDA Forest Service
Rocky Mountain Region
Forest Health Protection
Gunnison Service Center
216 N. Colorado St.
Gunnison, CO 81230

Overview

The Rio Grande National Forest currently faces a number of serious forest health issues. Among those that go through dramatic cycles, causing conspicuous damage in 'boom' phases followed by quiescent 'bust' phases, are spruce beetle and western spruce budworm. Several diseases cause more persistent, widespread damage, including root diseases and dwarf mistletoes, which are not mapped by aerial surveyors.

Spruce beetle (*Dendroctonus rufipennis*): While the number of acres that are currently being affected by spruce beetle continued to decline from 2015 to 2016 (from 137,000 to 93,000), it is important to note that 22,000 acres of the Rio Grande NF were newly infested (Table 1). Spruce beetle is now most active in the outer portions of the forest, particularly on the Sangre de Cristo Range in the Saguache Ranger District and adjacent lands in the San Isabel NF and south through the Conejos Peak Ranger District into New Mexico (Figure 1). The Rio Grande NF is the epicenter of a spruce beetle outbreak that has affected spruce/fir stands throughout southern Colorado (Figure 2). Acres affected by spruce beetle are declining due to exhaustion of the mature spruce cover type that is the beetle's primary host. Management efforts, primarily sanitation activities, can affect spruce beetle populations at a very local level. Now with most of the mature spruce being dead, salvage is the primary management option.

Western spruce budworm (*Choristoneura freemani*): The Rio Grande NF had 25,000 defoliated acres detected in 2016, compared to 46,000 in 2015. The primary hosts of western spruce budworm are Douglas-fir, subalpine fir, white fir, and to a lesser extent, Engelmann spruce. Significant impacts can occur in both mixed conifer and spruce-fir forest types. Feeding from this insect can cause growth loss, top-killing, and tree mortality, especially on suppressed trees. A combination of suitable habitat and favorable weather patterns have resulted in the current widespread outbreak in Colorado. Stand conditions contribute greatly to the budworm population's ability to increase to outbreak status. Reduced fire frequency allows shade tolerant white fir and Douglas-fir to increase in mixed conifer stands, providing favorable habitat for western spruce budworm. Multistory stands favor western spruce budworm survival as larvae disperse from overstory trees. Management activities such as reducing basal area, favoring ponderosa pine where possible, and thinning from below can render stands less susceptible to damage from western spruce budworm.

Douglas-fir beetle (*Dendroctonus pseudotsugae*): Douglas-fir mortality from Douglas-fir beetle is currently at a moderate level on the Rio Grande NF. A total of only 1,000 acres were

recorded in 2016. Mortality caused by Douglas-fir beetle tends to be dispersed, although there can be concentrated groups of mortality within a generally affected area.

Root diseases are important in the ecology and productivity of mixed conifer and spruce-fir stands on the Rio Grande NF. In spruce-fir, **Armillaria root disease** is usually most important, infecting both Engelmann spruce and subalpine fir. Subalpine fir often also becomes infested by western balsam bark beetle, and is usually killed while standing. Engelmann spruce more often falls due to decayed roots while still green. Infected spruce may serve as hosts for spruce beetle during non-epidemic conditions, and strip attacks can be found above infected roots. When infected spruce fall (windthrow), they can lead to increases in spruce beetle populations. The disease generally intensifies as stands mature.

In mixed conifer stands, **annosus root disease** (caused by *Heterobasidion occidentale*) is also important. White fir is the primary host of this disease. White fir has become more prevalent due to past selective harvesting of ponderosa pine and Douglas-fir as well as fire exclusion. As white fir has increased, so has the disease. Dense white fir stands are often severely affected. Because white fir is shade-tolerant, they are replaced by more white fir, and the disease intensifies. The severity of this disease on the Rio Grande NF may be outside the natural range of variability due to both fire exclusion and past harvesting practices.

Dwarf mistletoes cause significant growth loss, and over time can substantially impact forest productivity. Mortality can result when infestations are severe. The most important dwarf mistletoes on the Rio Grande NF are southwestern dwarf mistletoe (*Arceuthobium vaginatum* ssp. *cryptopodum*) infecting ponderosa pine and Douglas-fir dwarf mistletoe (*A. douglasii*), primarily infecting Douglas-fir. Forest management activities that do not address dwarf mistletoe usually increase abundance and severity, so it is important to carefully consider dwarf mistletoe in management plans.

Aerial Survey Highlights

Table 1. Acres of major damage agents detected in aerial survey. [a]

Agent	2015 Acres Affected	2016 Acres Affected	1996-2016 Cumulative Acres Affected	2016 New Acres Affected [b]
Spruce beetle	*137,000*	*93,000*	*610,000*	*22,000*
Western spruce budworm	*46,000*	*25,000*		
Aspen defoliation	*14,000*	*3,500*		
Douglas-fir beetle	*1,900*	*1,600*	*42,000*	*1,000*
Mountain pine beetle	*1,500*	*210*	*37,000*	*0*
Fir engraver	*40*	*130*		
Subalpine fir mortality	*790*	*110*		

[a] Due to the nature of aerial surveys, these data will only provide rough estimates of location, intensity and the resulting trend information for agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The data presented should only be used as a partial indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent. Using this data for purposes other than those for which it was intended may yield inaccurate or misleading results.

[b] since 1996

- Since 1996, spruce beetle has affected 1,715,000 acres in Colorado. The Rio Grande had 93,000 acres of active spruce beetle activity in 2016, of which 22,000 acres were newly reported.
- Western spruce budworm activity decreased in Colorado in 2016, but was locally abundant across the state. Aerial surveys detected 226,000 defoliated acres in the state in 2016 compared to 312,000 acres in 2015.

FHP Projects

- The Southwestern Colorado Bioclimate Project projects climate change impacts on tree species to aid forest adaptation efforts on the SJNF, RGNF, GMUG, Southern Ute Indian Tribe, Tres Rios BLM, and Mesa Verde National Park. Rocky Mountain Research Station is developing adaptation management recommendations based on the projections. We hope to hold a workshop for participants this spring.

Surrounding Area Conditions of Note

- A windthrow event impacted 660 scattered acres of Engelmann spruce in the Wet Mountains of the San Isabel National Forest. This will continue to provide ideal habitat for expanding spruce beetle populations (Figure 3) east of the Rio Grande NF.

Recent Reports and Resources

Forest Health Protection (FHP), in cooperation with the Colorado State Forest Service, conducts

an annual aerial forest health survey, ground surveys, and site visits to identify, assess, and map forest damage due to diseases and insects throughout the Region. The following is a list of recent reports and resources available.

- Technical Report R2-68. 2016. Bioclimate Models and Change Projections to Inform Forest Adaptation in Southwestern Colorado: Interim Report. Worrall JJ, Marchetti SB, Rehfeldt GE. Golden, Colorado: Forest Health Protection, State and Private Forestry and Tribal Relations, Rocky Mountain Region, US Forest Service. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd500723.pdf.
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We look forward to continued work with the SJNF regarding your forest disease and insect concerns. Please do not hesitate to contact us with your questions.

Gunnison Service Center

- Jim Worrall, Group Leader and Pathologist, jworrall@fs.fed.us, 970-642-4453
- Amy Lockner, Entomologist, alockner@fs.fed.us, 970-642-4448
- Suzanne Marchetti, Biological Science Technician, sbmarchetti@fs.fed.us, 970-642-4446

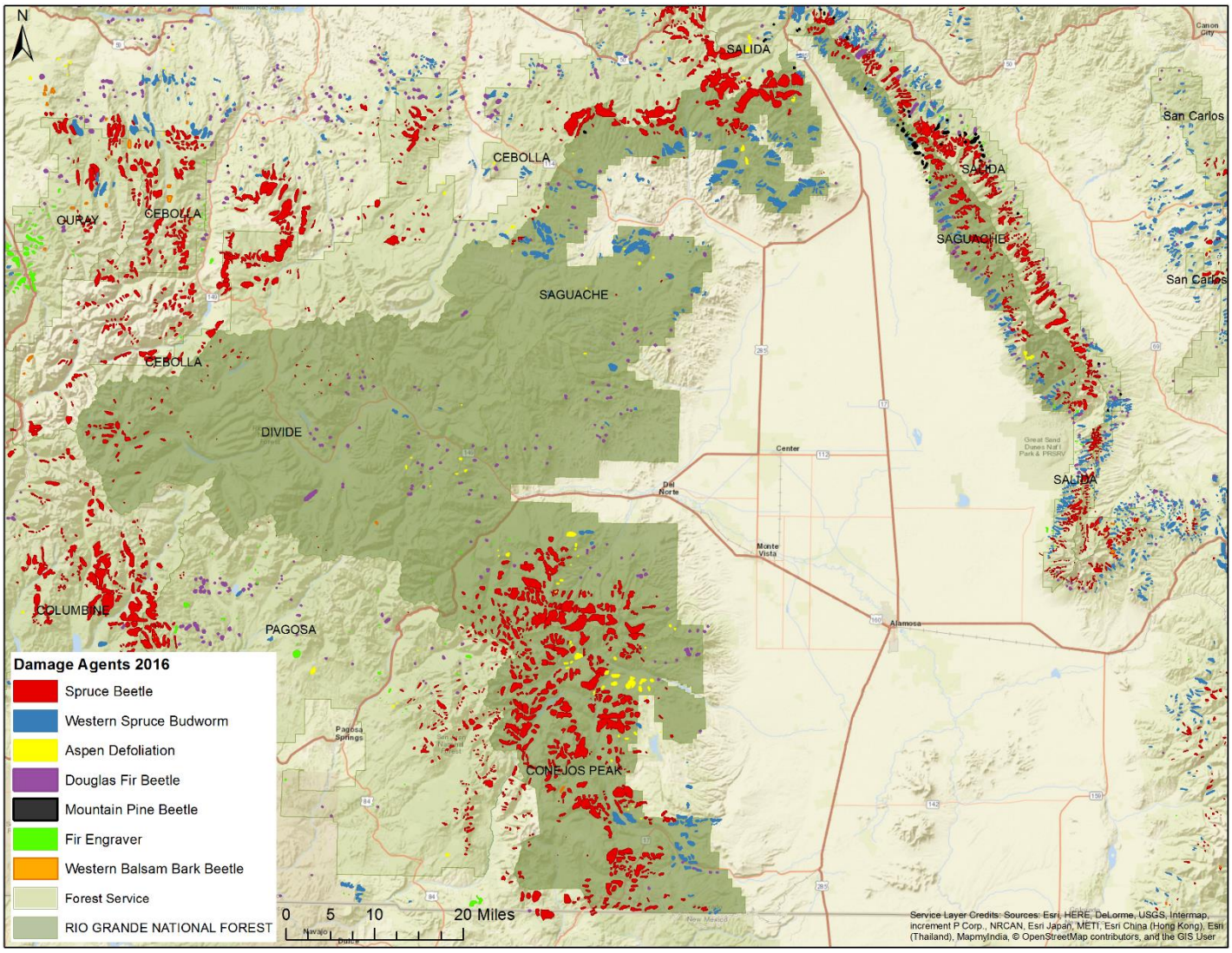

Figure 1. Damage detected in 2016 aerial detection survey.

Due to the nature of aerial surveys, these data only provide rough estimates of location of agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The data presented should only be used as a partial indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent.

Figure 2. A mix of recent and older mortality caused by spruce beetle on the Rio Grande National Forest. (Photo: Justin Backsen.)

Figure 3. An October 2016 wind storm toppled spruce trees on 660 scattered acres in the Wet Mountains, creating potential habitat for spruce beetles. (Photo: Bob Cain.)

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2016 Forest Insect and Disease Conditions, San Isabel National Forest

USDA Forest Service
Rocky Mountain Region
Forest Health Protection
Gunnison Service Center
216 N. Colorado St.
Gunnison, CO 81230

Overview

The San Isabel National Forest currently faces several serious forest health issues. Among those that go through dramatic cycles, causing conspicuous damage in 'boom' phases followed by quiescent 'bust' phases, are spruce beetle and western spruce budworm. Several diseases cause more persistent, widespread damage, including root diseases and dwarf mistletoes.

Spruce beetle (*Dendroctonus rufipennis*): The number of acres affected by spruce beetle on the San Isabel NF did not change from 2015 to 2016 (46,000 active acres in both years), but 24,000 acres were newly infested in 2016 (Table 1). Spruce beetle is now most active in the Saguache Mountains and Sangre de Cristo Mountains on the Salida District and the Wet Mountains on the San Carlos District (**Figure 1**). Acres affected by spruce beetle are declining overall in Colorado due to exhaustion of the mature spruce that is the beetle's primary host. However, the San Isabel likely has several more years left of spruce beetle activity. A windthrow event impacted 660 scattered acres of Engelmann spruce in the Wet Mountains. This will continue to provide ideal habitat for expanding spruce beetle populations **(Figure 2)**. Management efforts, primarily sanitation activities, can affect spruce beetle populations at a very local level. Sanitation is recommended when possible; otherwise salvage offers the opportunity to capture value and reduce hazards from dead standing trees on the San Isabel NF.

Western spruce budworm (*Choristoneura freemani*): The San Isabel NF had 40,000 defoliated acres detected in 2016, compared to 86,000 in 2015. The primary hosts of western spruce budworm are Douglas-fir, subalpine fir, white fir, and to a lesser extent, Engelmann spruce. Significant impacts can occur in both mixed conifer and spruce-fir forest types. Feeding from this insect can cause growth loss, top-killing, and tree mortality, especially on suppressed trees. A combination of suitable habitat and favorable weather patterns have resulted in the current widespread outbreak in Colorado. Stand conditions contribute greatly to outbreaks. Reduced fire frequency allows shade-tolerant white fir and Douglas-fir to increase in mixed conifer stands, improving habitat for western spruce budworm. Multistory stands of shade-tolerant species favor western spruce budworm survival as larvae disperse from overstory trees. Management activities such as reducing basal area, favoring non-hosts where possible, and thinning from below can render stands less susceptible to damage from western spruce budworm.

Subalpine fir mortality declined somewhat on the San Isabel NF, but is still important in high-elevation stands in the north near Leadville, and a small area in the southern San Carlos District **(Figure 1)**. It has occurred fairly consistently in large areas across the Region for over a decade.

It is generally caused by western balsam bark beetle (*Dryocoetes confusus*) and Armillaria root disease (caused by *Armillaria* spp.). Typically, the beetle attacks and kills subalpine fir with root disease. The resulting brood may attack neighboring, uninfected trees. It is also not unusual to find trees killed by root disease that are not attacked by the beetle. The relative contribution of the beetle and the fungus to tree mortality is difficult to determine, and can differ over time and among localities.

Douglas-fir beetle (*Dendroctonus pseudotsugae*): Douglas-fir mortality from Douglas-fir beetle is currently at a moderate level on the San Isabel NF. A total of only 1,000 acres were recorded in 2016. Mortality caused by Douglas-fir beetle tends to be dispersed, although there can be concentrated groups of mortality within a generally affected area. Douglas-fir beetle activity may increase in the future as stress from repeated defoliation by western spruce budworm makes Douglas-fir more vulnerable to bark beetle attack.

Mountain pine beetle (*Dendroctonus ponderosae*): Mountain pine beetle can kill ponderosa, lodgepole, and five-needle pines. These bark beetles are currently at very low levels, having declined quickly from outbreaks in ponderosa pine which occurred on the San Isabel NF more than a decade ago. Only 300 acres of new activity were mapped in 2016, almost all of which were limber pines. These high elevation sites can be difficult to ground check and limber pine mortality may also be due to limber pine engraver beetles (*Ips woodi*) or a combination of the two bark beetles. Currently, new limber pine mortality occurs east of Saguache, in the Sangre de Cristo mountain range **(Figure 3)**. Managing forests to increase age and species diversity and to lower stand densities can reduce overall susceptibility to mountain pine beetle.

Root diseases are important in the ecology and productivity of mixed conifer and spruce-fir stands on the San Isabel NF. In spruce-fir, **Armillaria root disease** is usually most important, infecting both Engelmann spruce and subalpine fir. As described above, diseased subalpine fir often is attacked by western balsam bark beetle, and is usually killed while standing. Engelmann spruce more often falls due to decayed roots while still green. Infected spruce may serve as hosts for spruce beetle during non-epidemic conditions, and strip attacks can be found above infected roots. When infected spruce fall (windthrow), they can lead to increases in spruce beetle populations. The disease generally intensifies as stands mature.

Where white fir occurs, **annosus root disease** (caused by *Heterobasidion occidentale*) is also important. White fir is the primary host of this disease. White fir has become more prevalent due to past selective harvesting of ponderosa pine and Douglas-fir as well as fire exclusion. As white fir has increased, so has the disease. Dense white fir stands are often severely affected. Because white fir is shade-tolerant, they are replaced by more white fir, and the disease intensifies. The severity of this disease on the San Isabel NF may be outside the natural range of variability due to both fire exclusion and past harvesting practices.

Dwarf mistletoes cause significant growth loss, and over time can substantially impact forest productivity. Mortality can result when infestations are severe. The most important dwarf mistletoes on the San Isabel NF are southwestern dwarf mistletoe (*Arceuthobium vaginatum* ssp. *cryptopodum*) infecting ponderosa pine and lodgepole pine dwarf mistletoe (*A. americanum*) in lodgepole pine. Forest

management activities that do not address dwarf mistletoe usually increase abundance and severity, so it is important to carefully consider dwarf mistletoe in management plans.

Although **Lophodermella needle casts** were detected by aerial survey on only a few acres on the San Isabel NF, this usually suggests that many more acres were infested. These diseases infect current-year needles of lodgepole pine, causing discoloration, then needle loss in the second year. Except in very susceptible populations, damage is often concentrated in lower crowns and small trees where it cannot be seen from the air, and flights may not occur during the time of year when discoloration is most conspicuous.

White pine blister rust is active on the west side of Mosca Pass in the Sangre de Cristo Mountains and in the Wet Mountains. Within the San Isabel NF, the rust has only been found on limber pine, but infected bristlecone pine have been found on the Great Sand Dunes National Park and Preserve. The distributions of the two species overlap extensively on the San Isabel NF.

In the long term, this invasive, exotic disease poses a substantial threat to 5-needle pines. Forest Health Protection conducts ground surveys to monitor spread and intensification and to detect new infestations. We are working with Rocky Mountain Research Station to explore and exploit resistance in pine populations through breeding and natural selection.

Aerial Survey Highlights

Table 1. Acres of major damage agents detected in aerial survey. [a]

Agent	2015 Acres Affected	2016 Acres Affected	1996-2016 Cumulative Acres Affected	2016 New Acres Affected [b]
Spruce beetle	*46,000*	*46,000*	*91,000*	*24,000*
Western spruce budworm	*86,000*	*40,000*		
Subalpine fir mortality	*5,700*	*4,300*		
Douglas-fir beetle	*400*	*910*	*18,000*	*1,000*
Wind damage	*85*	*660*		
Aspen defoliation	*3,000*	*420*		
Mountain pine beetle	*670*	*390*	*152,000*	*0*
Fir engraver	*2,100*	*250*		
Lophodermella needle cast	*1*	*8*		

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[b] since 1996

- Since 1996, spruce beetle has affected 1,715,000 acres in Colorado.

- Defoliation by western spruce budworm was detected in Colorado on 226,000 acres in in 2016 compared to 312,000 acres in 2015. It still remains abundant on many southern Colorado forests.
- Aspen defoliation decreased from 3,000 affected acres in 2015 to 420 acres in 2016 on the San Isabel NF.

FHP Projects

- The Southwestern Colorado Bioclimate Project projects climate change impacts on tree species to aid forest adaptation efforts on the SJNF, RGNF, GMUG, Southern Ute Indian Tribe, Tres Rios BLM, and Mesa Verde National Park. Portions of the San Isabel NF are included in the modeling area. Rocky Mountain Research Station is developing adaptation management recommendations based on the projections. We hope to hold a workshop for participants this spring.

Recent Reports and Resources

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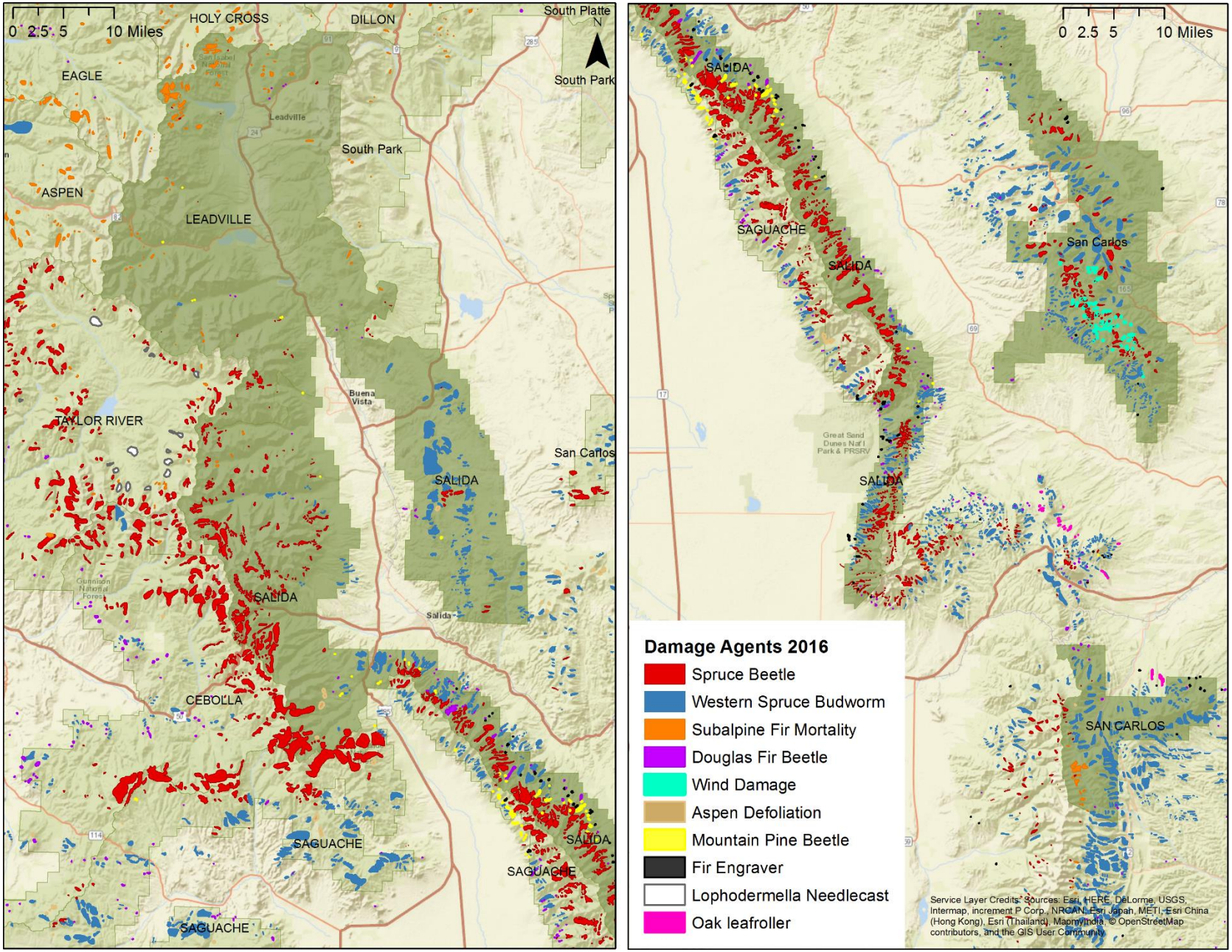

Figure 1. Damage detected in 2016 aerial detection survey.

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Figure 2. An October 2016 wind storm toppled spruce trees on 660 scattered acres in the Wet Mountains, creating potential habitat for spruce beetles. (Photo: Bob Cain.)

Figure 3. Limber pine killed by mountain pine beetle (middle) in the Sangre de Cristo Mountain Range, with Engelmann spruce killed by spruce beetle at the top. (Photo: Justin Backsen)

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Overview

The San Juan National Forest currently faces a number of serious forest health issues. Among those that go through dramatic cycles, causing conspicuous damage in 'boom' phases followed by quiescent 'bust' phases, are spruce beetle, roundheaded pine beetle, and western spruce budworm. Several diseases cause more persistent, widespread damage, including root diseases and dwarf mistletoes.

Spruce beetle (*Dendroctonus rufipennis*) affected 36,000 acres in 2016 on the San Juan NF, and 12,000 of those acres had not been previously affected since 1996 (**Table 1**). Since 1996, cumulative area affected is 237,000 acres. The spruce beetle outbreak on the San Juan will likely continue for several more years. In the absence of an unusual weather event such as extreme or unseasonable cold or large amounts of precipitation during the beetle's flight period, spruce beetles will likely impact the majority of spruce stands on the San Juan NF. Amounts of mortality in affected stands will vary greatly; some stands maintaining varying amounts of residual live trees, while other stands have mortality approaching 100%. Management efforts, primarily sanitation activities, can affect spruce beetle populations at a local level.

Roundheaded pine beetle (*Dendroctonus adjunctus*) has killed ponderosa pines on the San Juan NF for several years and affected 6,600 acres in 2016 (**Figures 1, 2, and 3**). In Colorado, this insect has been active primarily in the southwest, especially in the Lake Canyon area of Dolores County. Generally, epidemics of this insect tend to grow more slowly and are more localized than spruce beetle or mountain pine beetle. The persistence and expansion of this particular outbreak is remarkable. The Forest is commended for consistent efforts to address this unusual epidemic in the face of challenging market conditions.

Western spruce budworm (*Choristoneura freemani*) activity decreased on the San Juan NF from 31,000 acres of defoliation to 18,000 acres in 2016. The primary hosts of western spruce budworm are Douglas-fir, subalpine fir, white fir, and to a lesser extent, Engelmann spruce. Significant impacts are occurring in both mixed conifer and spruce-fir forest types. Feeding from this insect can cause growth loss, top-killing, and tree mortality, especially on suppressed trees. A combination of suitable habitat and favorable weather patterns have resulted in the current widespread outbreak in Colorado. Stand conditions contribute greatly to the budworm population's ability to increase to outbreak status. Reduced fire frequency allows shade-

tolerant white fir and Douglas-fir to increase in mixed conifer stands, improving habitat for western spruce budworm. Multistory stands of shade-tolerant species favor western spruce budworm survival as larvae disperse from overstory trees. Management activities such as reducing basal area, favoring ponderosa pine where possible, and thinning from below can render stands less susceptible to damage from western spruce budworm.

Douglas-fir beetle (*Dendroctonus pseudotsugae*) affected 1,900 acres in 2016. This includes 1,000 new acres where Douglas-fir beetle was not detected by aerial surveys in recent years. Mortality from Douglas-fir beetle is currently at a moderate level on the San Juan NF, and mostly occurs on the eastern side of the Columbine and Pagosa Ranger Districts (**Figure 1**). Mortality caused by Douglas-fir beetle tends to be dispersed, although there can be concentrated mortality within a generally affected area.

Root diseases are important in the ecology and productivity of mixed conifer and spruce-fir stands on the San Juan National Forest. In spruce-fir, **Armillaria root disease** is usually most important, infecting both Engelmann spruce and subalpine fir. Subalpine fir often also becomes infested by western balsam bark beetle, and is usually killed while standing. Engelmann spruce more often falls due to decayed roots while still green. Infected spruce may serve as hosts for spruce beetle during non-epidemic conditions, and strip attacks can be found above infected roots. When infected spruce fall (windthrow), they can lead to increases in spruce beetle populations. The disease generally intensifies as stands mature.

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Western spruce budworm	*31,000*	*18,000*		
Roundheaded pine beetle	*3,700*	*6,600*		
Aspen defoliation	*110*	*3,700*		
Douglas-fir beetle	*2,100*	*1,900*	*81,000*	*1,000*
Fir engraver	*4,600*	*1,900*		
Subalpine fir mortality	*1,300*	*1,400*		
Western pine beetle	*60*	*100*		
Mountain pine beetle	*0*	*0*	*28,000*	*0*

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- Since 1996, spruce beetle has affected 1,715,000 acres in Colorado. The San Juan had 36,000 acres of active spruce beetle activity in 2016, of which 12,000 acres were newly reported.
- Defoliation by western spruce budworm was detected in Colorado on 226,000 acres in 2016, compared to 312,000 acres in 2015. It still remains abundant on many southern Colorado forests.
- Roundheaded pine beetle infested 78% more acres in 2016 than in 2015 on the Mancos-Dolores Ranger District. In these areas damage is generally severe (high mortality).
- Aspen defoliation increased from 110 affected acres in 2015 to 3,700 acres in 2016. Although Marssonina leaf blight can also cause severe defoliation, field observations suggest that most of the damage mapped is due to defoliating insects.

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We look forward to continued work with the San Juan NF regarding your forest disease and insect concerns. Please do not hesitate to contact us with your questions.

Gunnison Service Center

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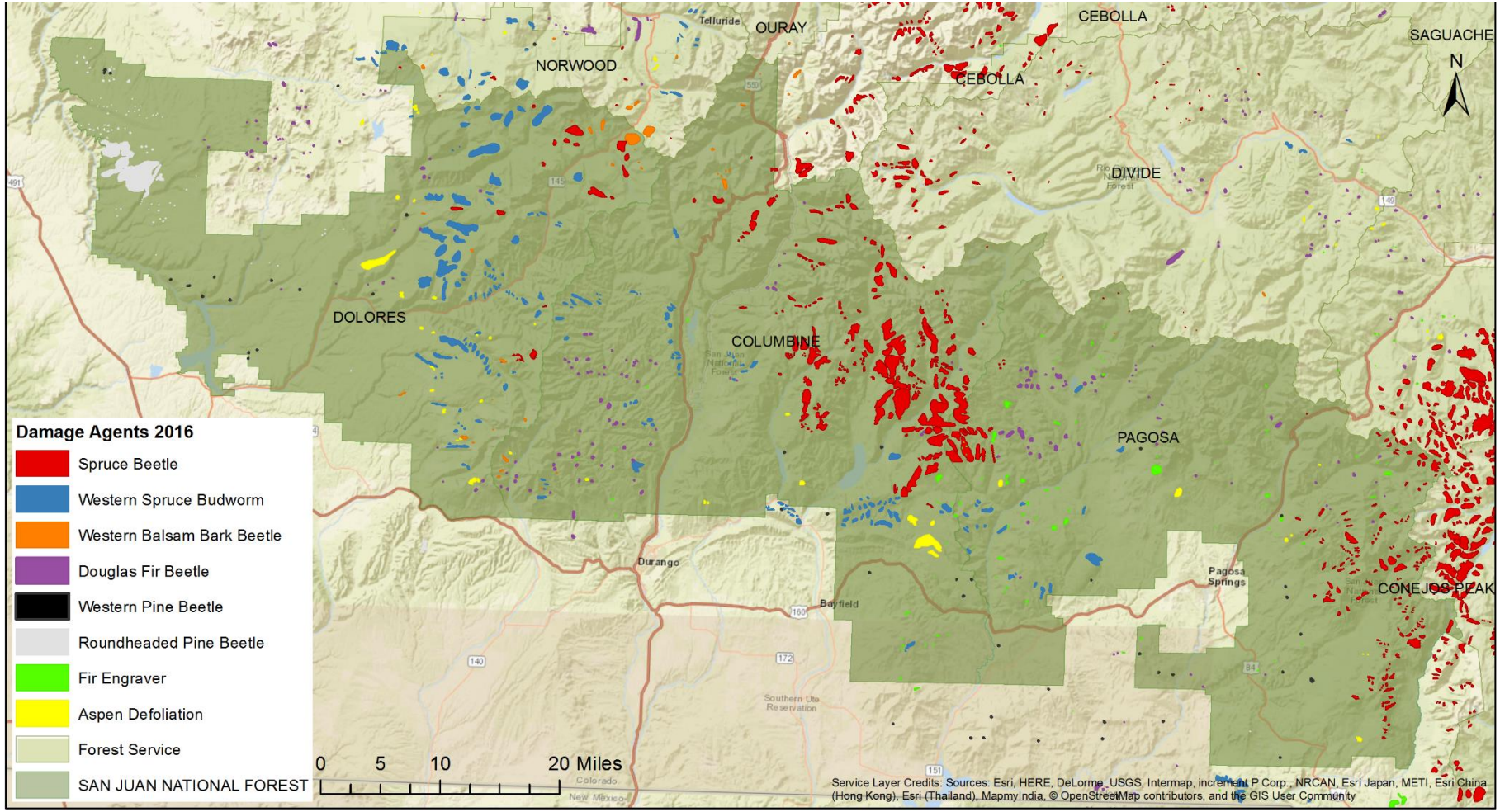

Figure 1. Damage detected in 2016 aerial detection survey.
Due to the nature of aerial surveys, these data only provide rough estimates of location of agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The data presented should only be used as a partial indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent.

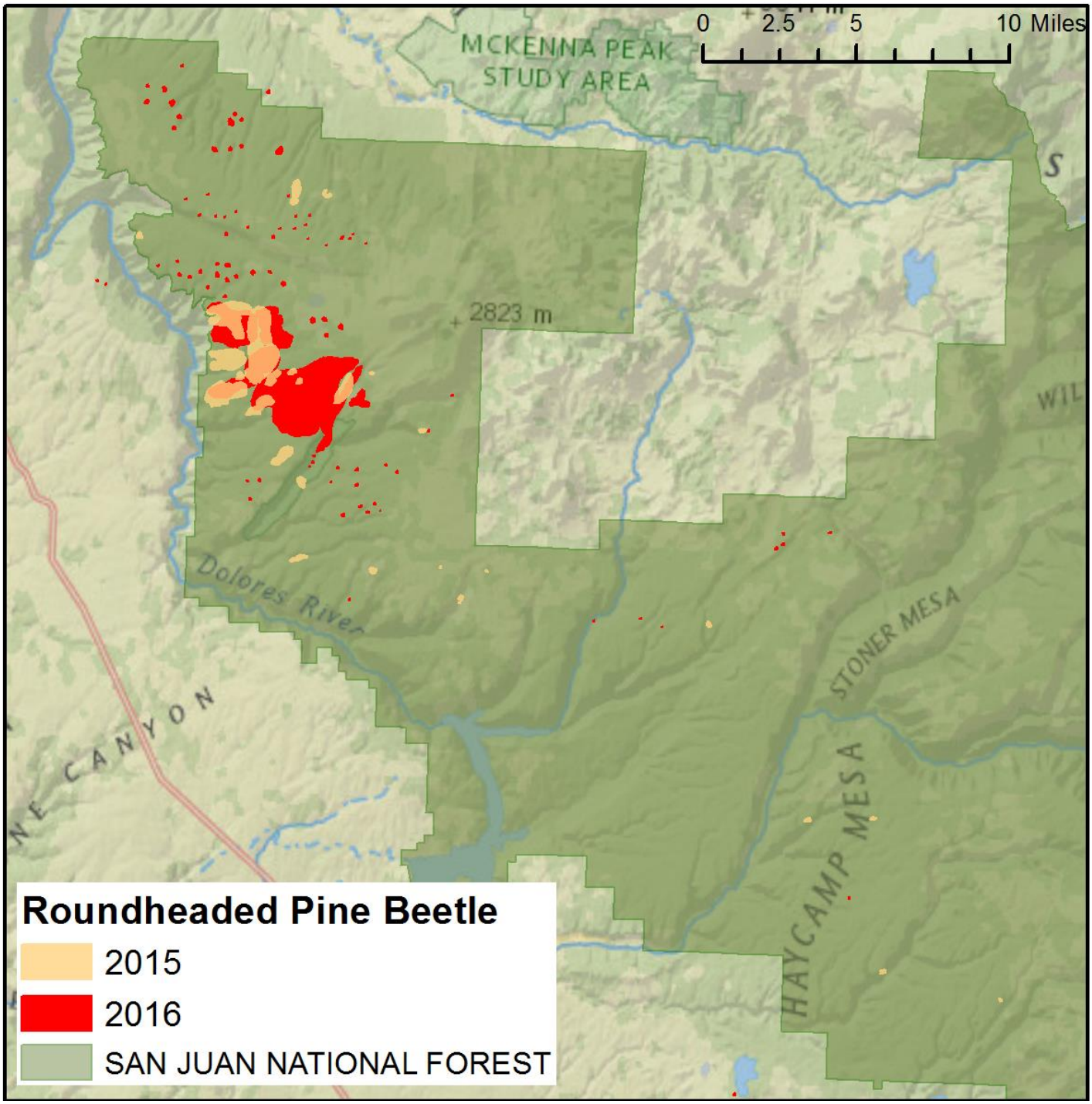

Figure 2. Roundheaded pine beetle in 2015 and 2016 aerial detection survey on the western San Juan National Forest.

Polygons of intermediate color were active in both years.

Due to the nature of aerial surveys, these data only provide rough estimates of location of agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The data presented should only be used as a partial indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent.)

Figure 3. Ponderosa pines killed by roundheaded pine beetle in Dolores County. (Photo: Dan West.)

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2016 FOREST HEALTH HIGHLIGHTS: SHOSHONE NATIONAL FOREST

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- There has been an ongoing spruce beetle epidemic in the Shoshone National Forest. Acreage affected decreased dramatically between 2015 and 2016, with 35,000 acres reported in 2015 and only 7,500 acres detected in 2016. The epicenter of activity continues on the Wind River Ranger District. (**Fig. 1)**. Preventive spraying is used to protect trees in campgrounds.

Figures 1 a. & b. From left to right, spruce beetle mortality near Brooks Lake (1a); hazard tree removal burn pile and residual spruce beetle killed trees within Brooks Lake Campground (1 b). (Photos by K. Schotzko.)

- Western spruce budworm activity has fluctuated over the past few years, but remains elevated. In 2016, 14,000 acres were affected (**Fig. 2 & Fig. 4**); mostly in the Clarks Fork drainage and surrounding areas. The heaviest defoliation is occurring on Douglas-fir, often with defoliation of 50-100% of mature tree crowns. Seedlings and saplings are also being heavily defoliated in these areas.

Figure 2. Photos of western spruce budworm defoliation. (Photos by K. Schotzko.)

- Mountain pine beetle mortality of five-needle and lodgepole pine decreased dramatically from 14,000 acres in 2015 to 490 acres in 2016. Two hundred acres of the mortality was in 5-needle pines, and 290 acres were in lodgepole pine (**Fig. 3 & 4**). At this point, mountain pine beetle activity is mostly in the south, northwest of Lander. There are scattered remnant pockets of mortality throughout the rest of the forest. Verbenone is being used to protect high value 5-needle pines.

Figure 3. Mountain pine beetle mortality in 5 needle pines on Blue Ridge. (Photo by K. Schotzko.)

- Western balsam bark beetle-caused mortality of subalpine fir was detected on 2,000 acres (**Fig. 4**). Subalpine fir decline is often attributed to damage from western balsam bark beetle, *Armillaria* root disease, and potentially other damage agents.

- In general, aspen is in good shape. As older trees die, the stands often regenerate from root suckers. Sooty bark canker continues to be the most damaging agent in aspen stands, followed by Cytospora canker and bronze poplar borer.

- Persistent disease problems that are often not detected during aerial detection survey include:
  - White pine blister rust, which continues to intensify and cause limber and whitebark pine mortality. White pine blister rust can be particularly damaging on seedlings and small trees, which is exacerbating the widespread mortality that has been caused by mountain pine beetle to the overstory over the past 10 years.
  - Dwarf mistletoe continues to affect lodgepole, limber, and whitebark pines.
  - Comandra blister rust disease is found at high levels in lodgepole pines, particularly on the Wind River Ranger District.

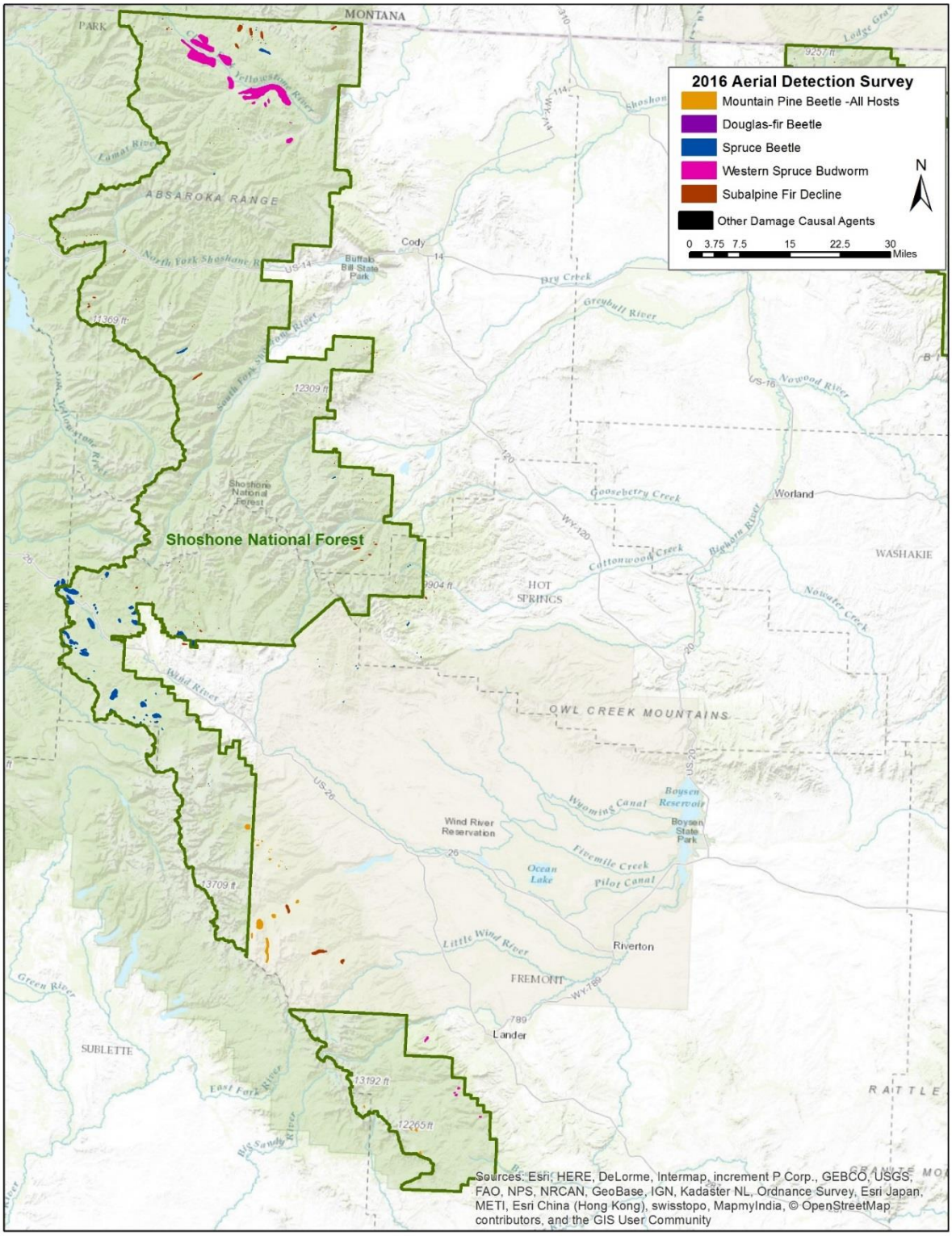

Figure 4. Aerial detection survey map of the Shoshone National Forest: 2016.

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2016 Forest Insect and Disease Conditions, White River National Forest

USDA Forest Service
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Forest Health Protection
Gunnison Service Center
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Overview

While mountain pine beetle populations have dropped so low on the White River National Forest that their activity was not detected by aerial surveys in 2016, a number of significant forest health issues persist. Widespread mortality continues in subalpine fir, caused by Armillaria root disease and western balsam bark beetle, and in Douglas-fir, caused by Douglas-fir beetle. Discoloration and defoliation were common in aspen due to Marssonina leaf blight and in conifers due to western spruce budworm. While the aspen damage varies greatly from year to year with the weather, western spruce budworm may have longer outbreaks where stand conditions are favorable. Several additional diseases cause very persistent, widespread damage, including root diseases and dwarf mistletoes.

Subalpine fir mortality occurs in high-elevation forests across the White River NF. It decreased in 2016, but is still the most important form of damage on the Forest (**Table 1, Figure 1**). It has occurred fairly consistently in large areas across the Region for over a decade. Subalpine fir mortality is generally caused by **western balsam bark beetle** (*Dryocoetes confusus*) and **Armillaria root disease** (caused by *Armillaria* spp.). Typically, the beetle attacks and kills subalpine fir with root disease. The resulting brood may attack neighboring, uninfected trees. It is also not unusual to find trees killed by root disease that are not attacked by the beetle. The relative contribution of the beetle and the fungus to tree mortality is difficult to determine, and can differ over time and among localities.

Western spruce budworm (*Choristoneura freemani*) activity heavily increased on the White River NF from 1,400 acres of defoliation to 22,000 acres in 2016. Notable activity is scattered through the Flat Tops Wilderness and one active area is north of Aspen (**Figure 1**). The primary hosts of western spruce budworm on the White River National Forest are Douglas-fir, subalpine fir, and to a lesser extent, Engelmann spruce. Significant impacts occur in both Douglas-fir and spruce-fir forest types. Feeding from this insect can cause growth loss, top-killing, and tree mortality, especially on suppressed trees. A combination of suitable habitat and favorable weather patterns have resulted in widespread outbreaks in Colorado. Stand conditions contribute greatly to outbreaks. Multistory stands of shade-tolerant species favor western spruce budworm survival as larvae disperse from overstory trees. Management activities such as reducing basal area, favoring non-host trees where possible, and thinning from below can render stands less susceptible to damage from western spruce budworm.

As in 2015, discoloration and defoliation of aspen were abundant on the White River National Forest. **Marssonina leaf blight** discolors foliage, then causes defoliation in midsummer. In 2015, 24,000 acres were recorded; this dropped to 7,400 acres in 2016. Damage was most severe in the Blanco Ranger District, especially in the western Flat Tops Wilderness. This disease tends to vary with spring and summer moisture, but the high

populations that developed in 2015 have also carried into 2016. Mortality can occur if trees are heavily infected in several consecutive years.

Douglas-fir beetle (*Dendroctonus pseudotsugae*) affected 3,800 acres in 2016; 3,000 acres are new activity mapped from aerial survey. Mortality is scattered throughout Hardscrabble and Red Table Mountains, in the Maroon Bells Wilderness, and the eastern side of the Flat Tops Wilderness. (**Figure 1**). Mortality caused by Douglas-fir beetle tends to be dispersed, although there can be concentrated mortality within a generally affected area. Douglas-fir beetle activity may increase in the future if repeated defoliation by western spruce budworm occurs.

Spruce beetle (*Dendroctonus rufipennis*) affected only 230 acres in 2016 on the White River NF, and only 31,000 acres have been affected since 1996 (Table 1). The spruce beetle outbreak in the 1940's and early 1950's killed most of the mature spruce in the Flat Tops Wilderness. It is likely the current outbreak that the GMUG, Rio Grande, San Juan, and San Isabel NF are experiencing will not affect the Flat Tops Wilderness portion of the White River NF. However, the Maroon Bells Wilderness, south of Aspen, is at risk if spruce beetle populations on the northern Gunnison NF continue to move north. Amounts of mortality in affected stands will vary greatly; some stands maintaining varying amounts of residual live trees, while other stands could have mortality approaching 100%. Management efforts, primarily sanitation activities, can affect spruce beetle populations at a local level.

Root diseases are important in the ecology and productivity of conifer cover types on the White River National Forest. **Armillaria root disease** is usually most important, especially in spruce-fir stands. It infects both Engelmann spruce and subalpine fir. As described above, infected subalpine fir is often attacked by western balsam bark beetle, and is usually killed while standing. Engelmann spruce more often falls due to decayed roots while still green. Infected spruce may serve as hosts for spruce beetle during non-epidemic conditions, and strip attacks can be found above infected roots. When infected spruce fall (windthrow), they can lead to increases in spruce beetle populations. The disease generally intensifies as stands mature.

Dwarf mistletoes cause significant growth loss and can substantially impact forest productivity. Mortality can result when infestations are severe. The most important dwarf mistletoe on the White River NF is **lodgepole pine dwarf mistletoe** (*Arceuthobium americanum*; **Figs. 2 and 3**). Stand-replacing fire is a natural regulator of the disease. Fire exclusion has led to increased spread and intensification of dwarf mistletoe. In the absence of stand-replacing fire, silviculture can be used to regulate the disease. Forest management activities that do not address dwarf mistletoe usually increase abundance and severity.

As noted in the service trip report cited below, this disease poses a clear and present threat to regenerating lodgepole pine in campgrounds previously affected by mountain pine beetle on the Dillon Ranger District. Infection is severe in the residual overstory, in part because mountain pine beetle avoids heavily infected lodgepole pine (McGregor 1978, Roe & Amman 1970, Ziegler 1978). If the infected overstory trees are not removed promptly, the disease will spread to the understory, leading to chronic infection through the life of the new stand. The results are stunting, development of witches' brooms, top kill, and early mortality.

Aerial Survey Highlights

Table 1. Acres of major damage agents detected in aerial survey. [a]

Agent	2015 Acres Affected	2016 Acres Affected	1996-2016 Cumulative Acres Affected	2016 New Acres Affected [b]
Subalpine fir mortality	*51,000*	*37,000*		
Western spruce budworm	*1,400*	*22,000*		
Marssonina leaf blight (aspen defoliation)	*2,900*	*3,800*		
Marssonina leaf blight (aspen discoloration)	*21,000*	*3,600*		
Douglas-fir beetle	*1,100*	*3,800*	*30,000*	*3,000*
Spruce beetle	*1,400*	*230*	*31,000*	*0*
Mountain pine beetle	*110*	*0*	*386,000*	*0*
Western pine beetle	*60*	*100*		

[a] Due to the nature of aerial surveys, these data will only provide rough estimates of location, intensity and the resulting trend information for agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The data presented should only be used as a partial indicator of insect and disease activity, and should be validated on the ground for actual location and causal agent. Using this data for purposes other than those for which it was intended may yield inaccurate or misleading results.

- Since 1996, spruce beetle has affected 1,715,000 acres in Colorado. The White River NF had 230 acres of active spruce beetle activity in 2016, all of which occurred on acres previously reported in recent years.
- Defoliation by western spruce budworm was detected in Colorado on 226,000 acres in 2016, compared to 312,000 acres in 2015. Aerial detection increased to 22,000 acres on the White River National Forest.

Recent Reports and Resources

Forest Health Protection (FHP), in cooperation with the Colorado State Forest Service, conducts an annual aerial forest health survey, ground surveys, and site visits to identify, assess, and map forest damage due to diseases and insects throughout the Region. The following is a list of recent reports and resources available.

- Service Trip Report LSC-16-14, Dillon Ranger District Recreation Site Review.
- Dwarf Mistletoes: Ecology and Management in the Rocky Mountain Region
- Forest Health Protection
    - Other Forest Condition Reports
    - Other Regional Reports
    - Aerial Detection Survey
        - Shapefiles
        - Data tables by state, county, and forest available by request
    - Mapping and Reporting
- Forest Health Technology Enterprise Team
    - Risk Map
    - National Forest damage Agent Range Maps

- Forest Pest Conditions

We look forward to continued work with the White River NF regarding forest disease and insect concerns. Please do not hesitate to contact us with your questions.

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Figure 1. Damage detected in 2016 aerial detection survey of the White River National Forest.
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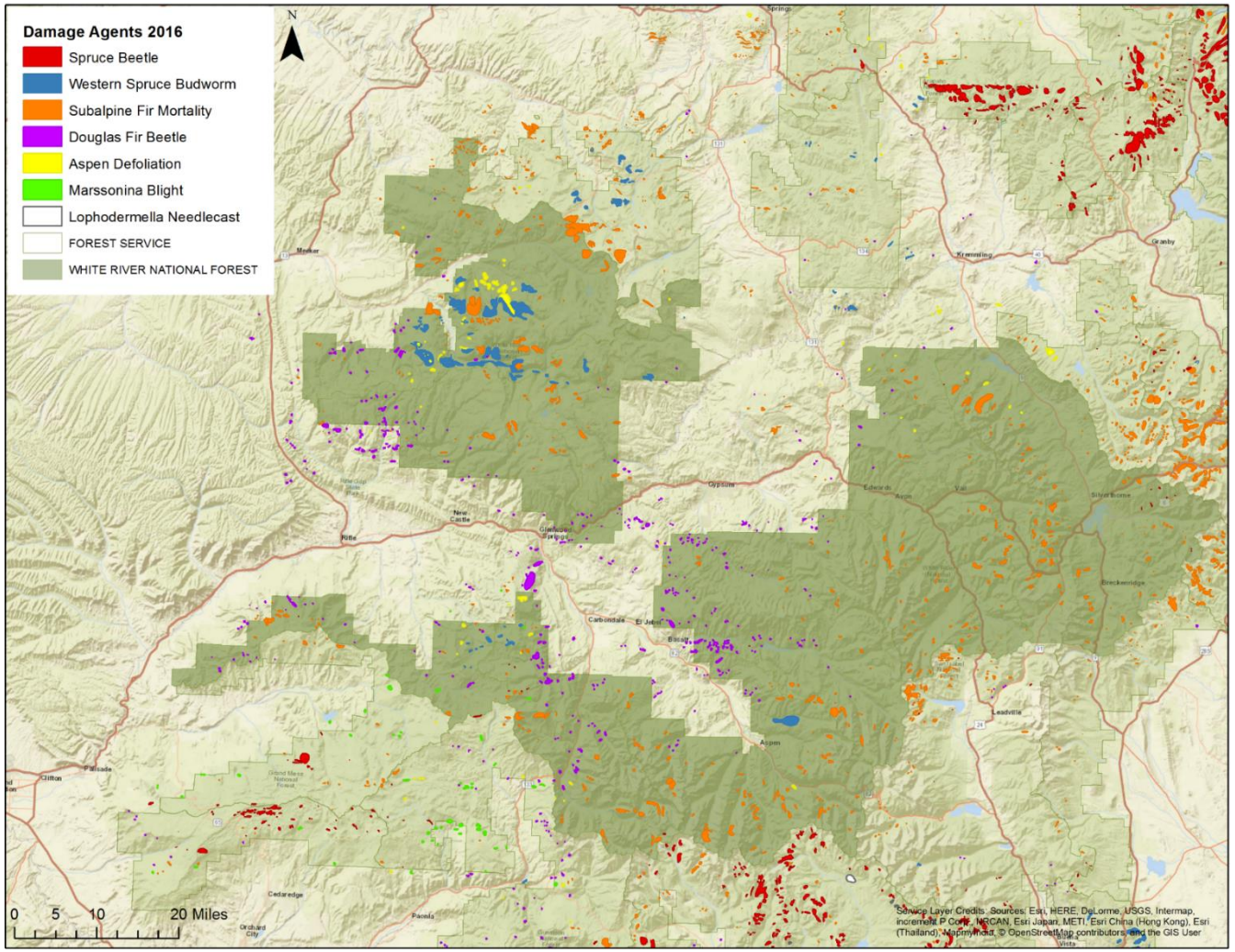

Figure 2. Lodgepole pine infected with dwarf mistletoe adjacent to a WUI/salvage clearcut near Dillon. (Photo by Bob Cain.)

Figure 3. Advanced regeneration infected with dwarf mistletoe in the clearcut described in **Fig 2**. (Photo by Bob Cain.)

Literature Cited

McGregor MD. 1978. Management of mountain pine beetle in lodgepole pine stands in the Rocky Mountain area. In: Kibbee DL, Berryman AA, Amman GD, Stark RW, editors. Theory and Practice of Mountain Pine Beetle Management in Lodgepole Pine Forests. Symposium Proceedings. Washington State University, Pullman, WA: Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, ID. p 129-139.

Roe AL, Amman GD. 1970. The mountain pine beetle in lodgepole pine forests. Research Paper INT-71. Missoula, MT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 23 p.

Ziegler RS. 1978. The vegetation dynamics of *Pinus contorta* forest, Crater Lake National Park, Oregon [Master's thesis]. Corvallis, OR: Oregon State University. 182 p.

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Section 2 States' FHH reports

Links to the 2016 Forest Heath Highlights' reports from each state in the Rocky Mountain Region
Colorado
Kansas
Nebraska
South Dakota
Wyoming

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Section 3 - 2016 Aerial Detection Survey Highlights and Maps for Region 2

See the Aerial Detection Survey: Highlights and Maps for 2016:

Please contact **R2 Forest Health Protection** Roy Mask rmask@fs.fed.us 303-275-5061; Jeri Lyn Harris jerilynharris@fs.fed.us 303-275-5155; Brian Howell behowell@fs.fed.us 303-236-8001. To obtain the 2016 ADS summary report.

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Section 4 Documentation & Acknowledgements

Reference for Citation and Public Notices:

Harris J.L. (comp.); R2 FHP staff, and States' Forest Health specialists 2017. **2016 Forest Health Conditions of the Rocky Mountain Region (R2)**. USDA Forest Service. State & Private Forestry & Tribal Relations, Forest Health Protection, R2-SPF&TR_16-RO-31. 70 pp.

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Information shown is based upon data compiled as of March 2016. References and GPS data provided upon request. For more information, **contact R2 FHP**.

Acknowledgements:

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